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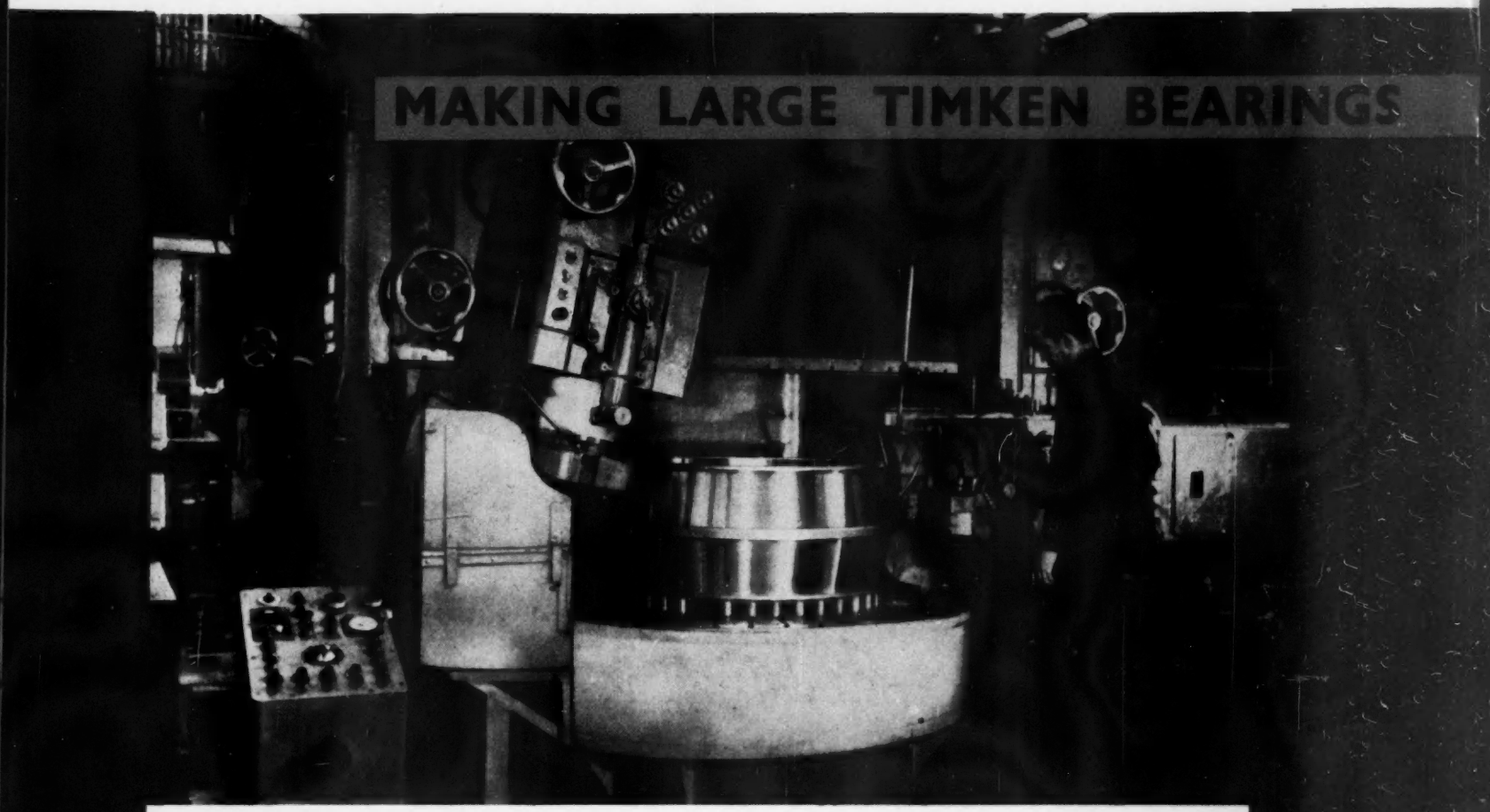

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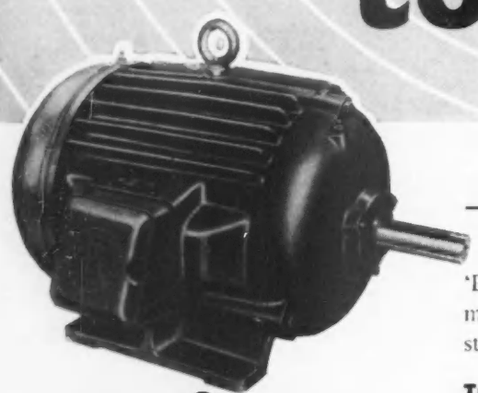

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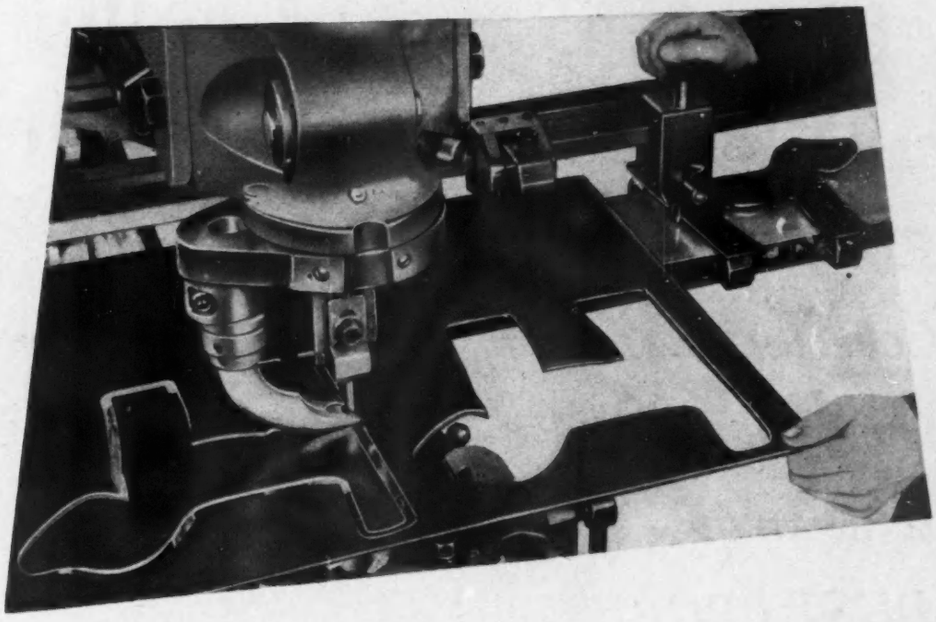

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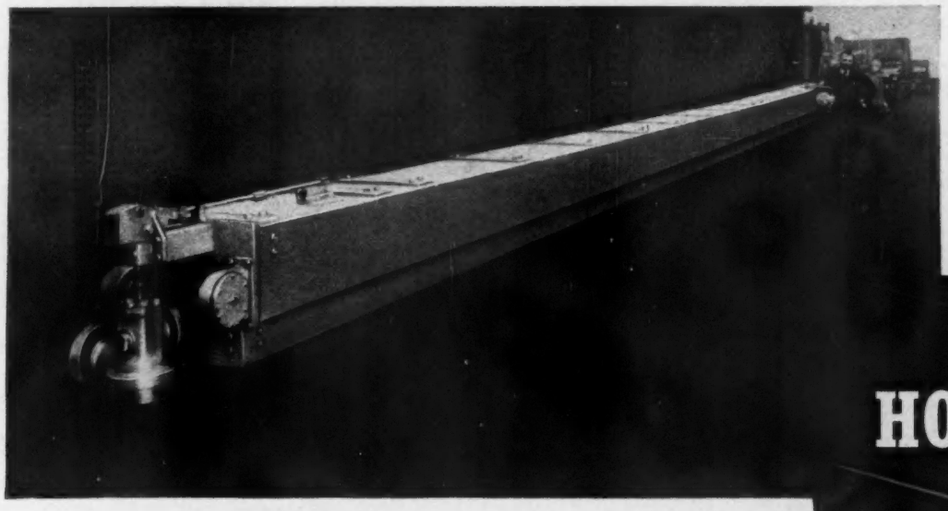

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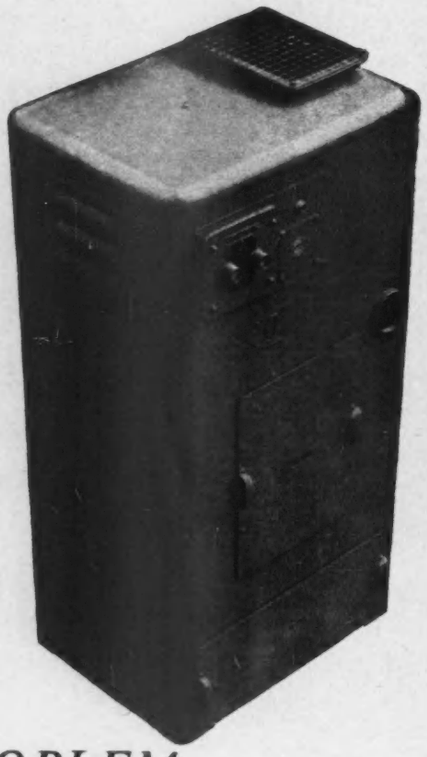

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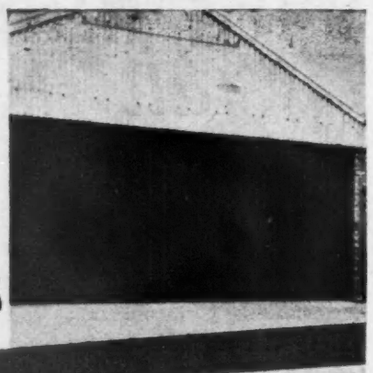

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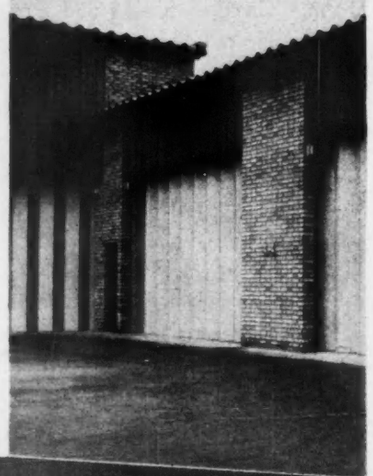

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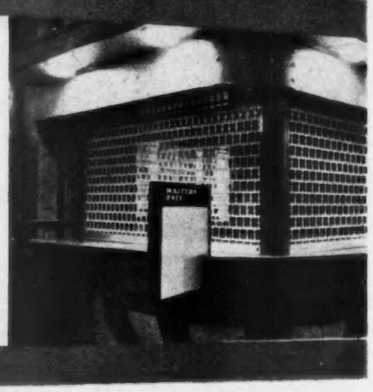

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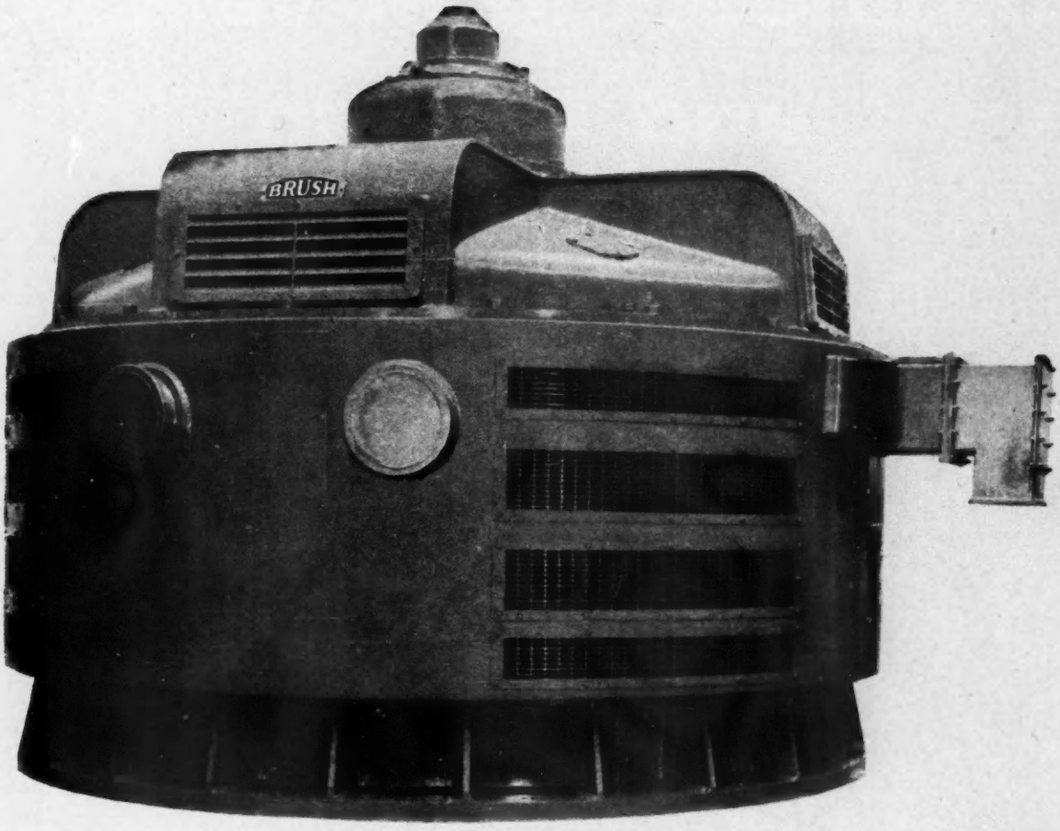

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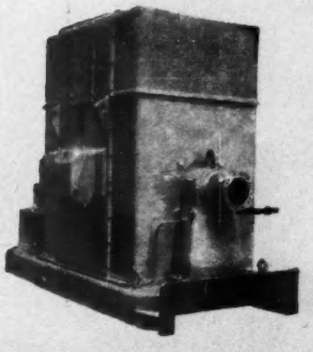

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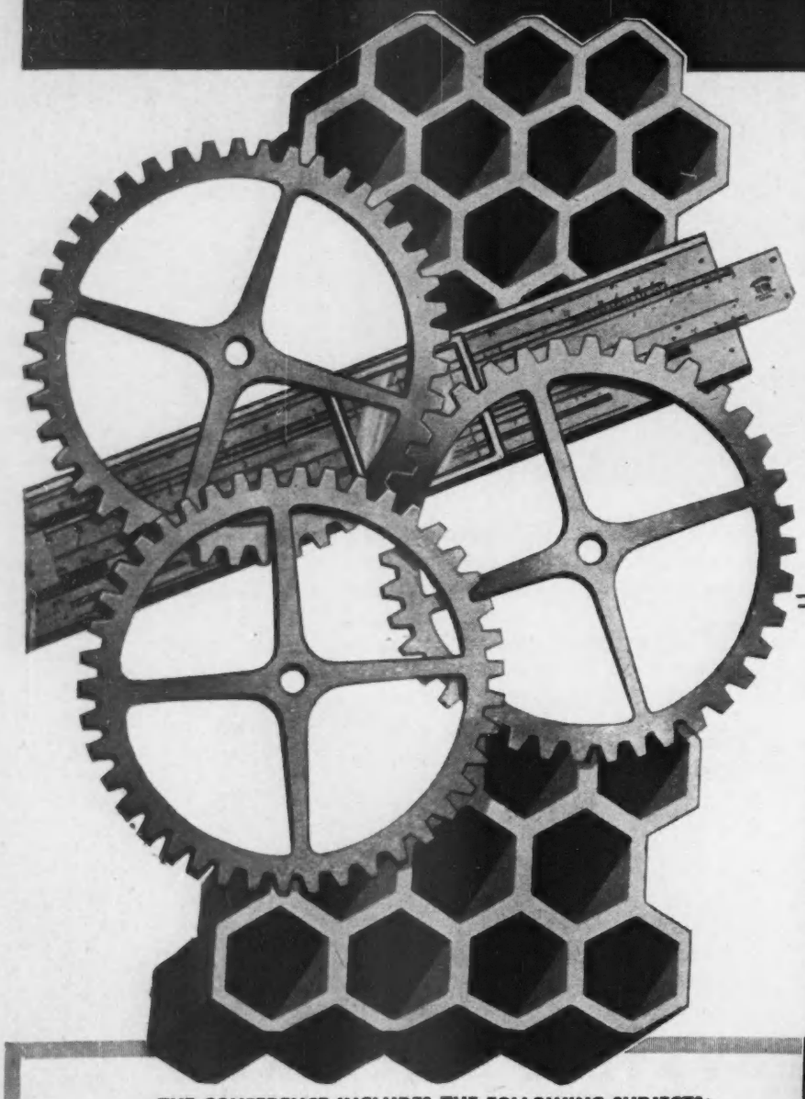

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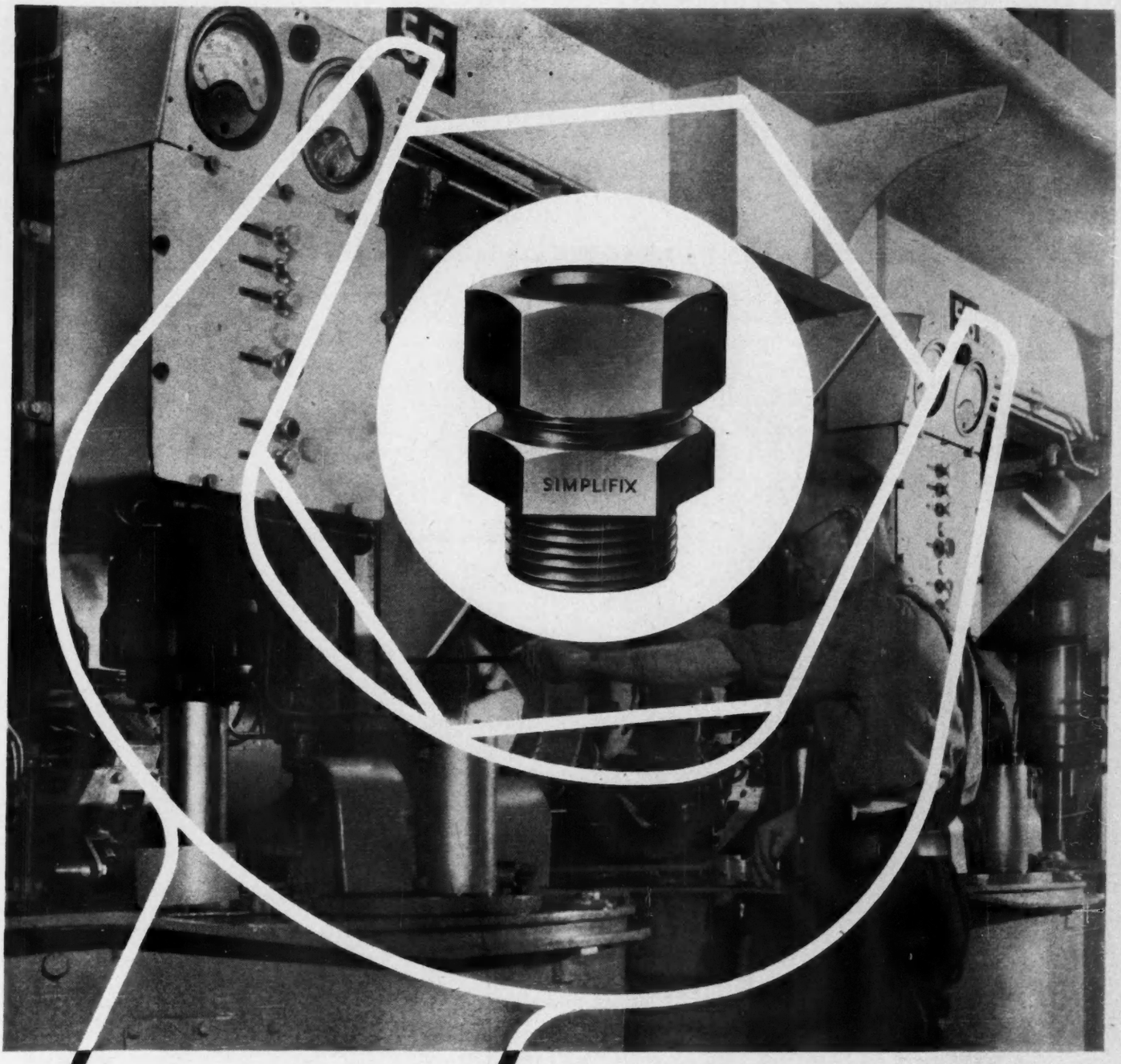

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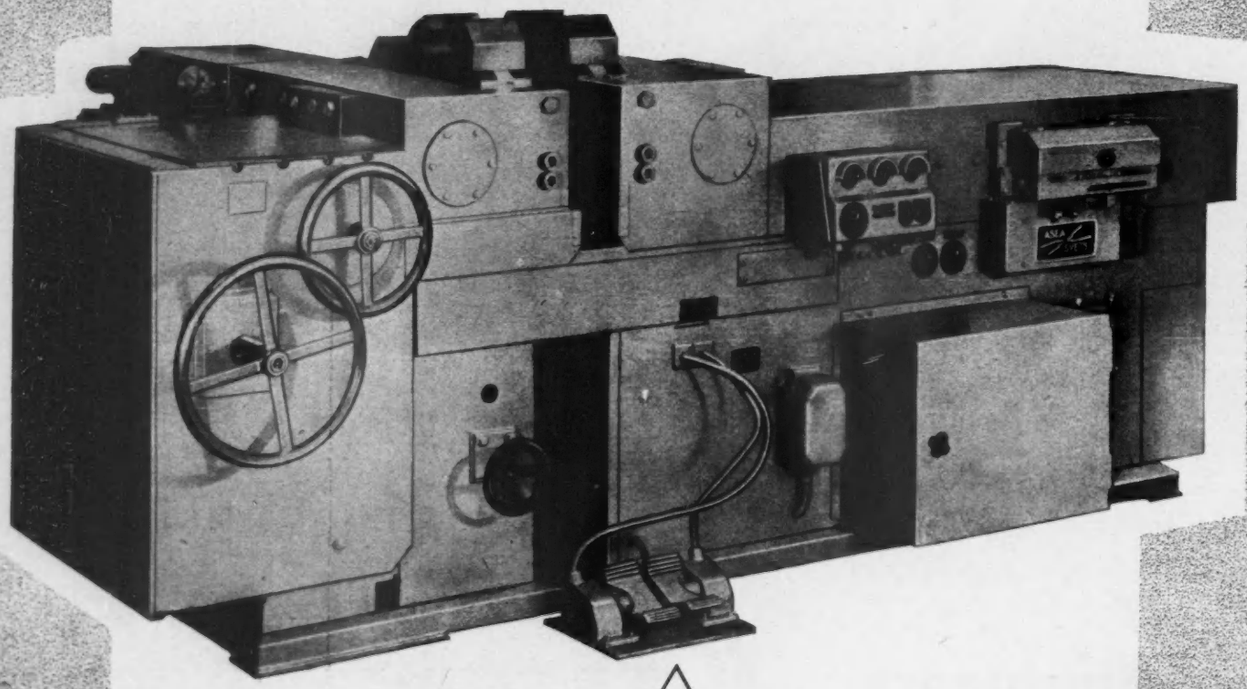

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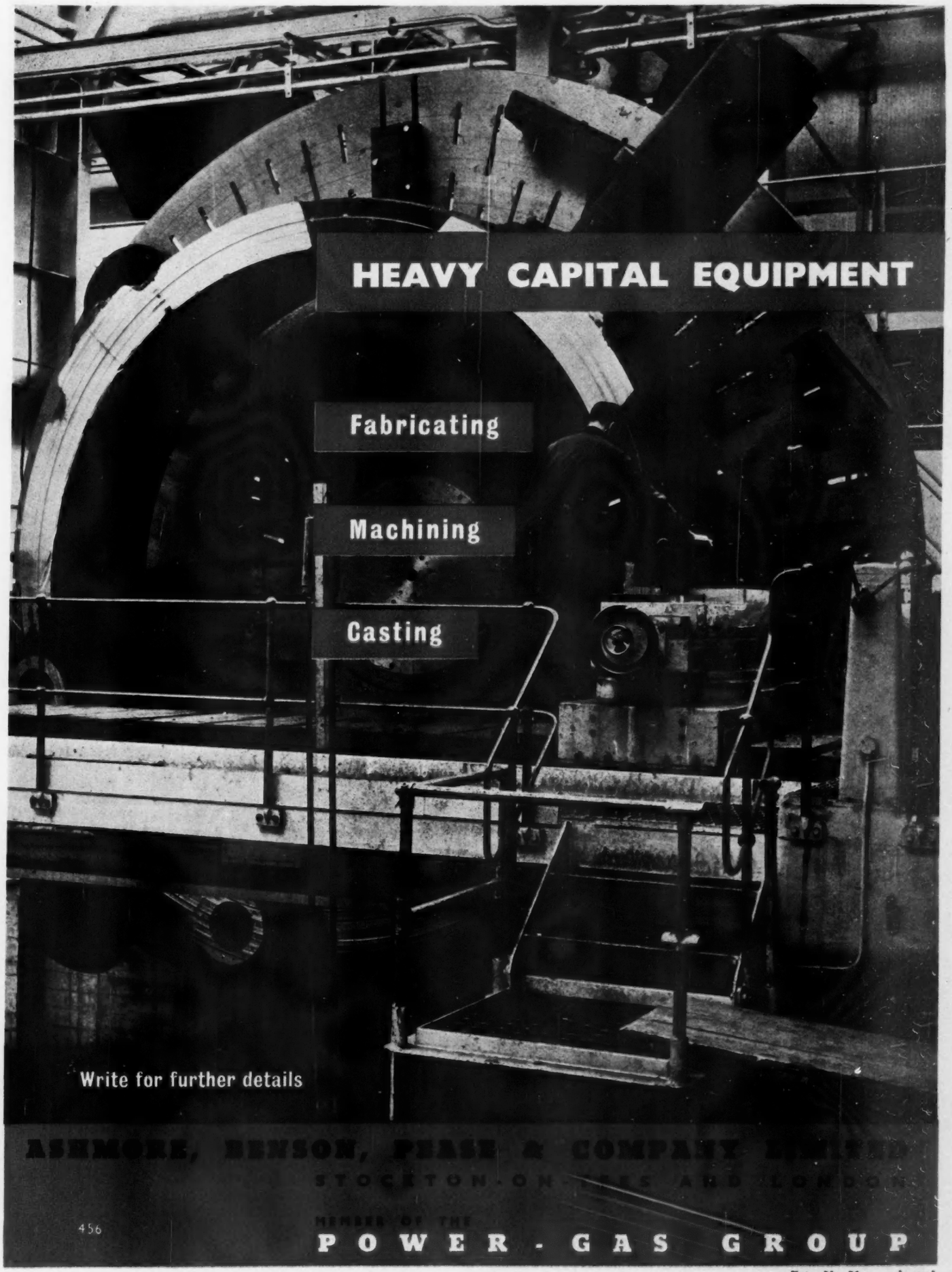

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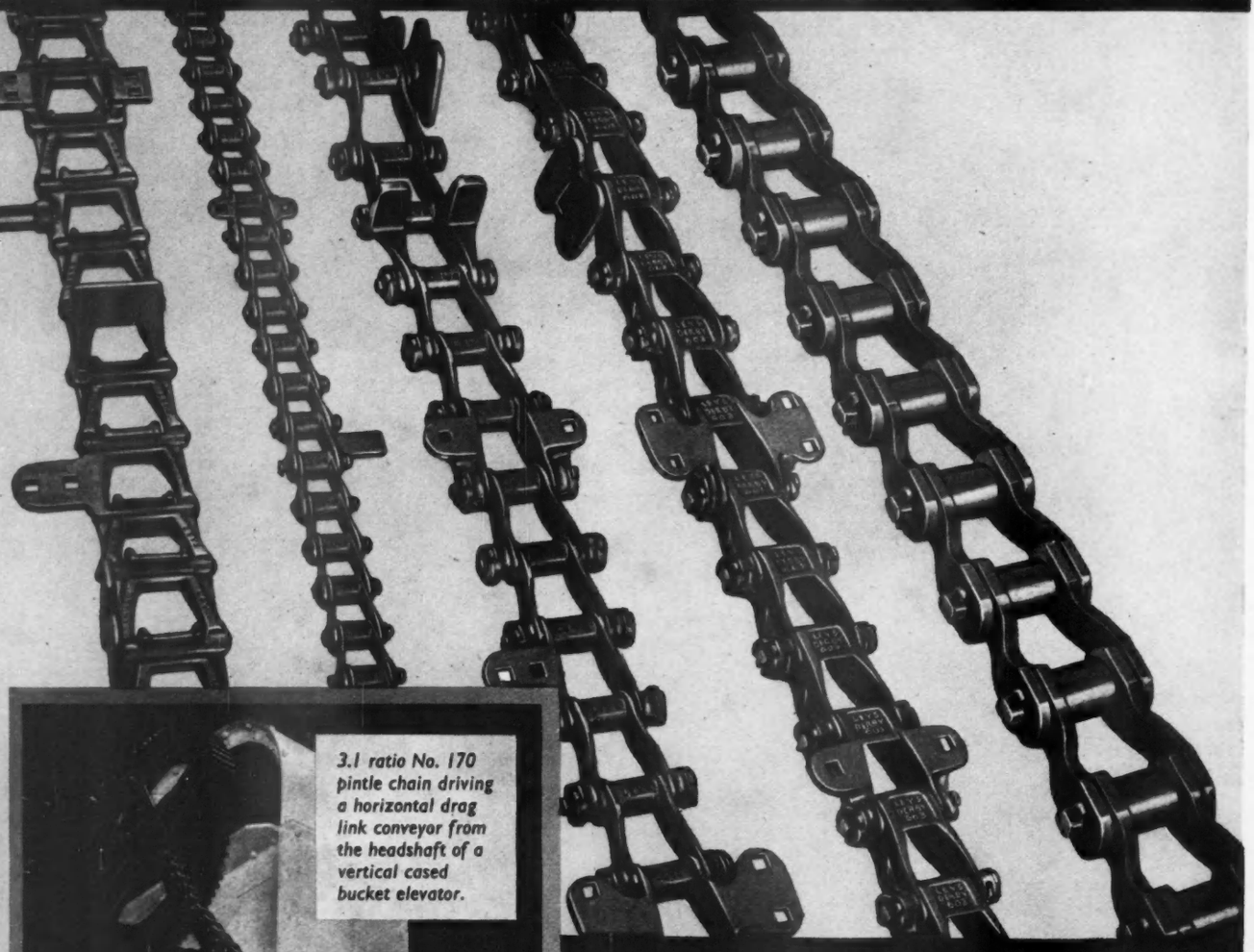

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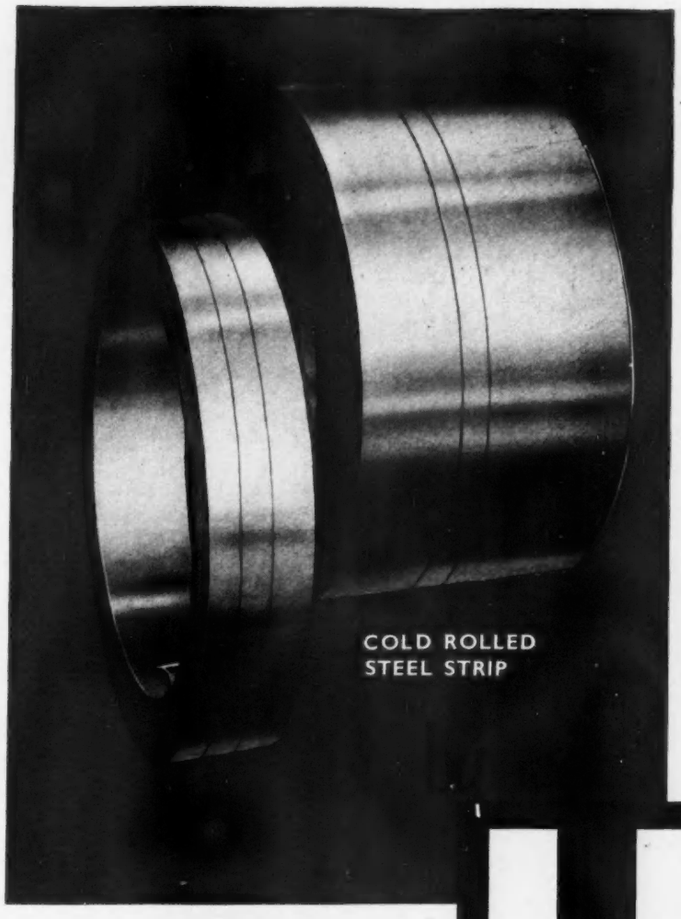

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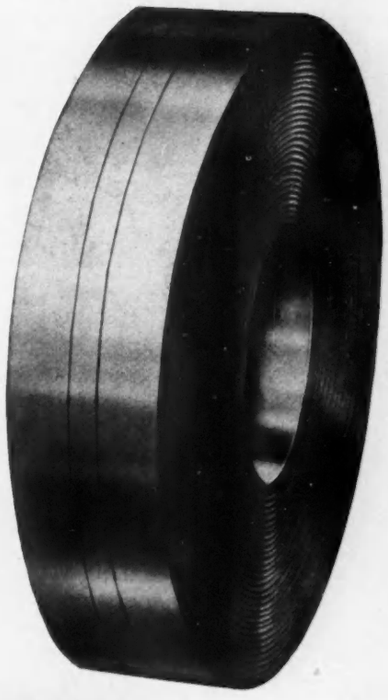

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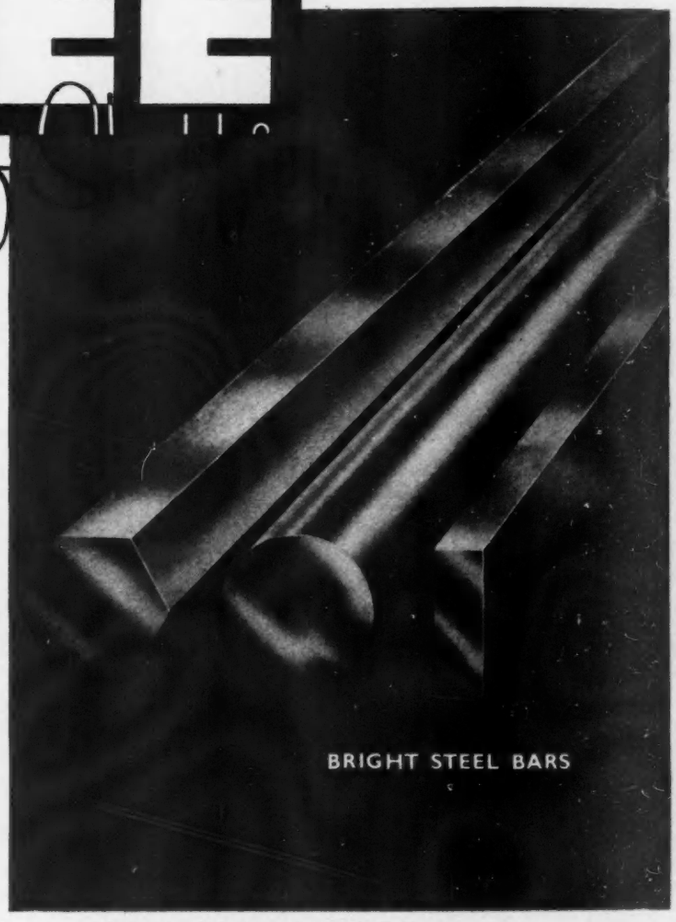

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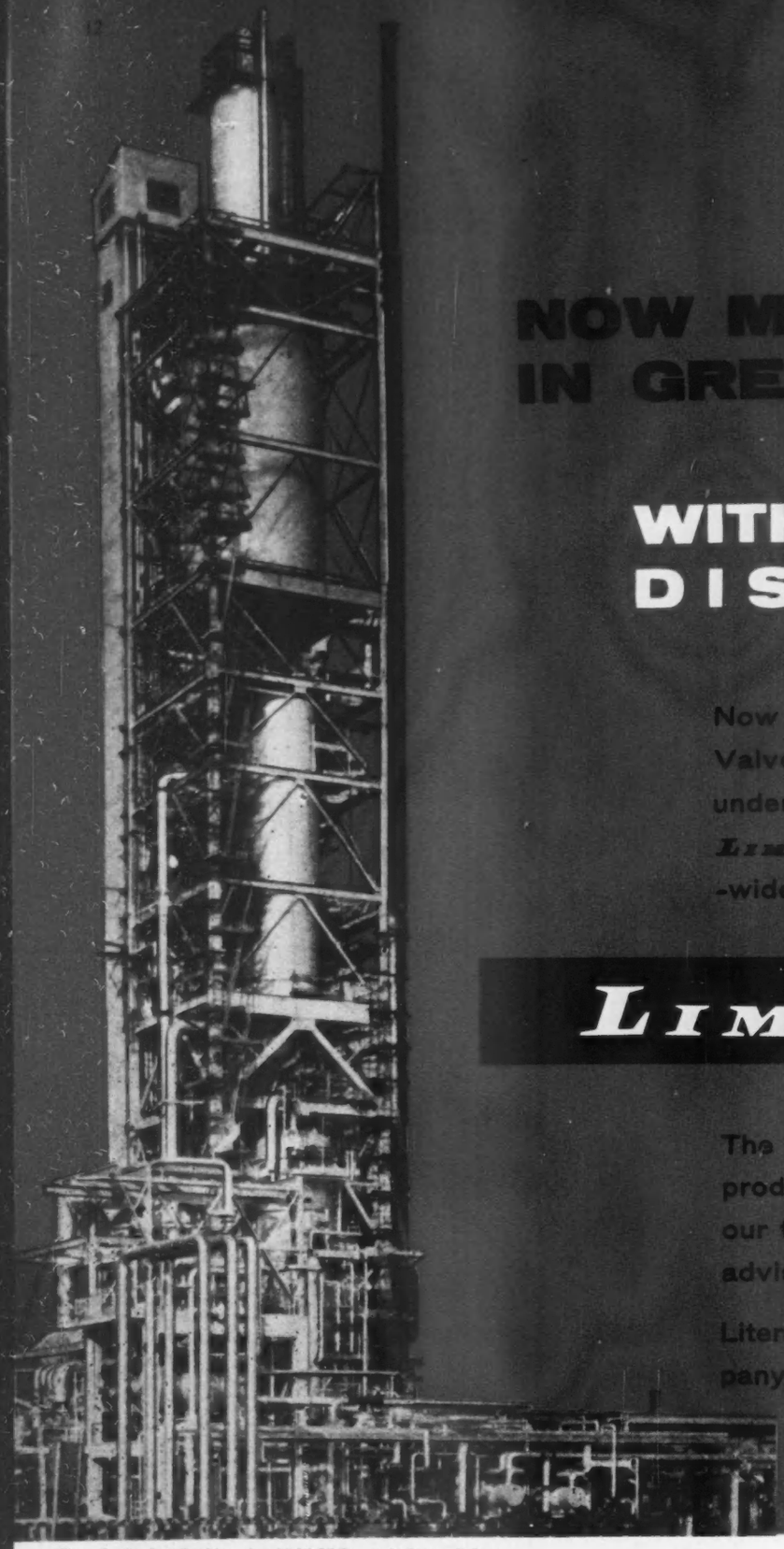

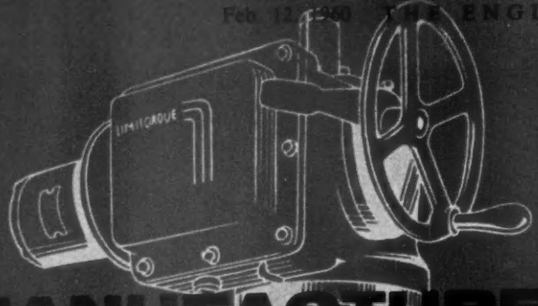

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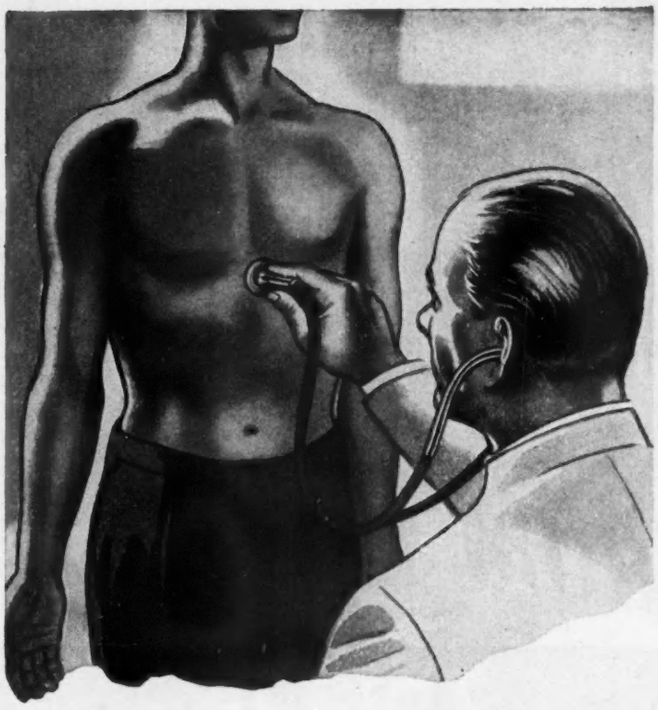

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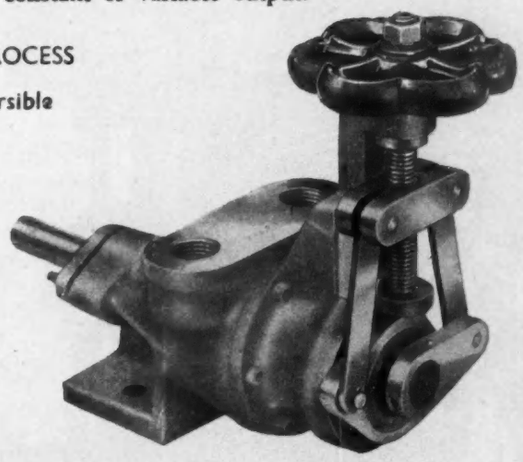

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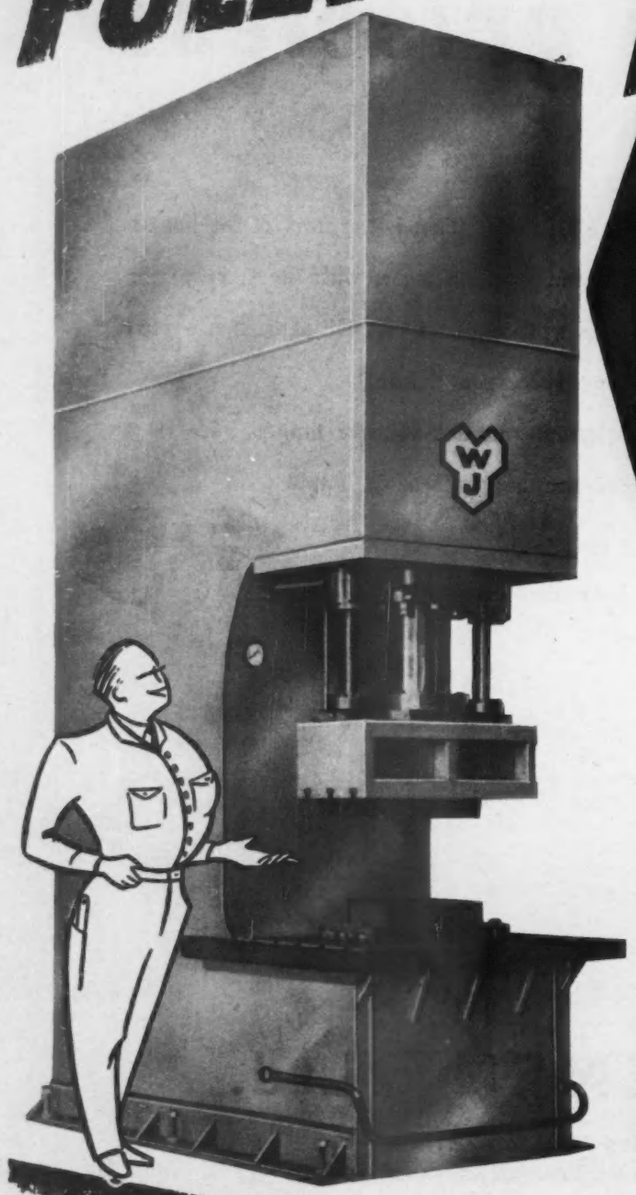

This is PRESTIGE EUROPE'S MOST ADVANCED OPEN GAP PRESS

SPEED. The approach stroke of the PRESTIGE 200 ton open gap press is 180 inches per minute. Pressings on all rams 30 inches per minute and the speed of the return is 210 inches per minute.

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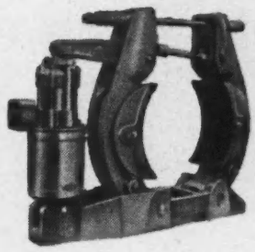

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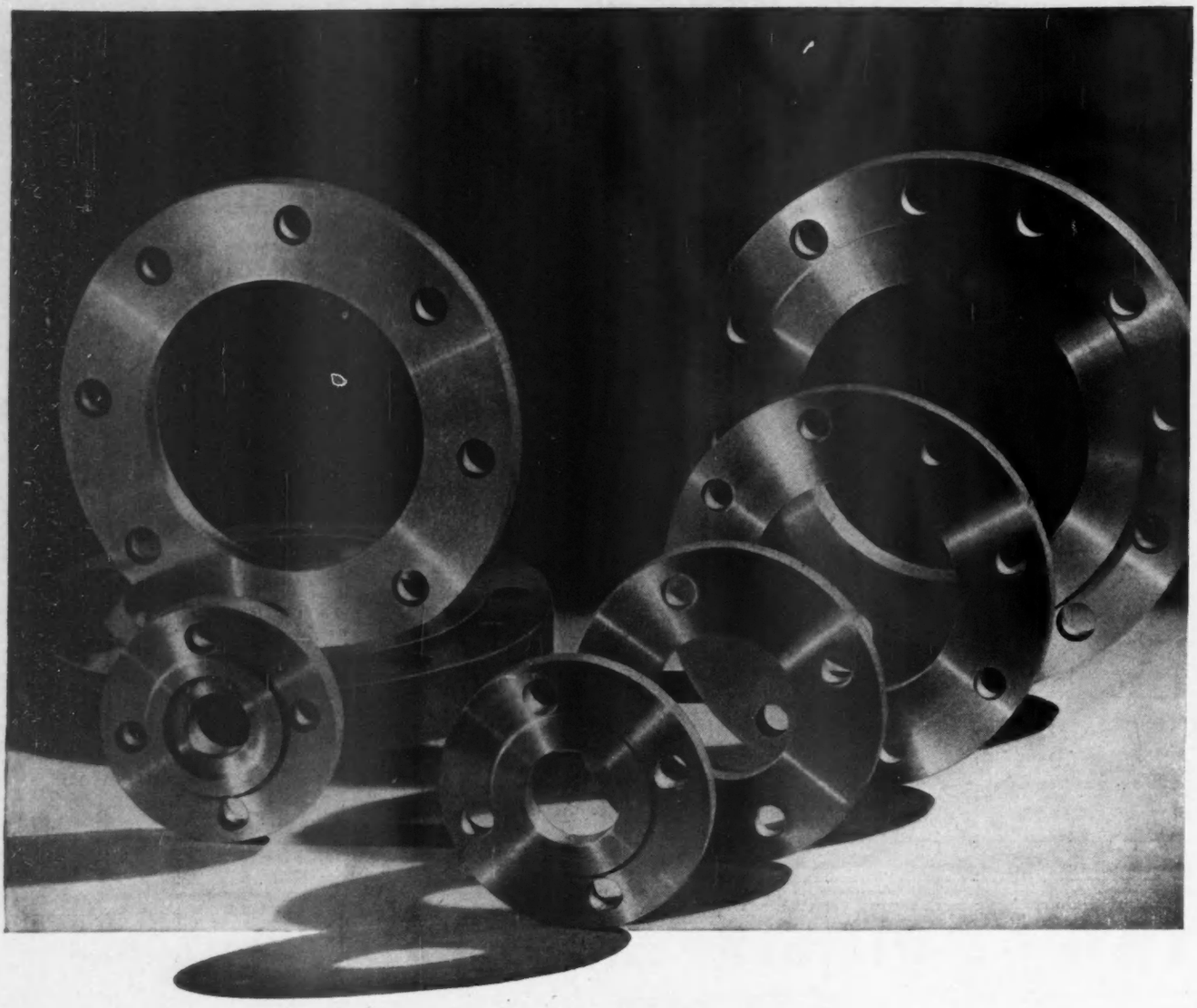

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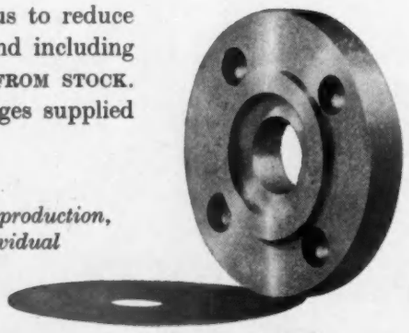

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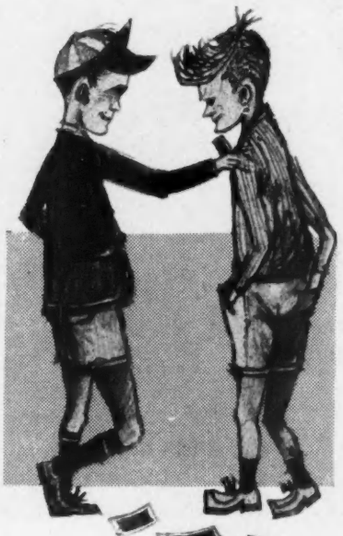

NO! That can't be done. Harland Swallowglide and Harland Uniglide pumpsets are NOT interchangeable—each is built for a specific duty. Uniglides are for handling usually clean water, whilst Swallowglides are for pumping slurries, sludges and solids in suspension.

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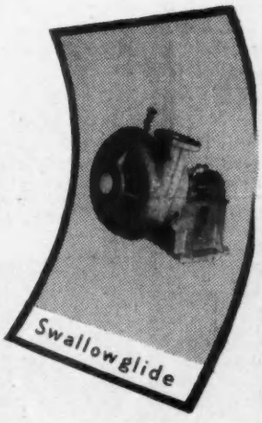

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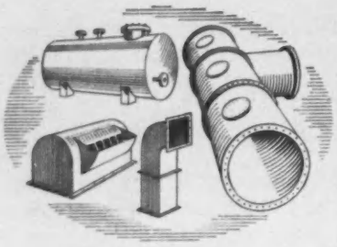

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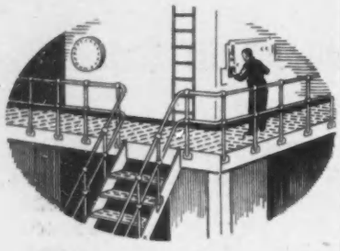

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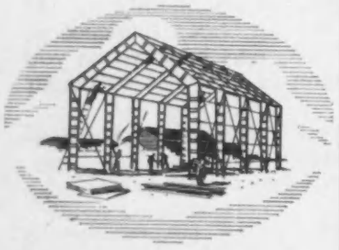

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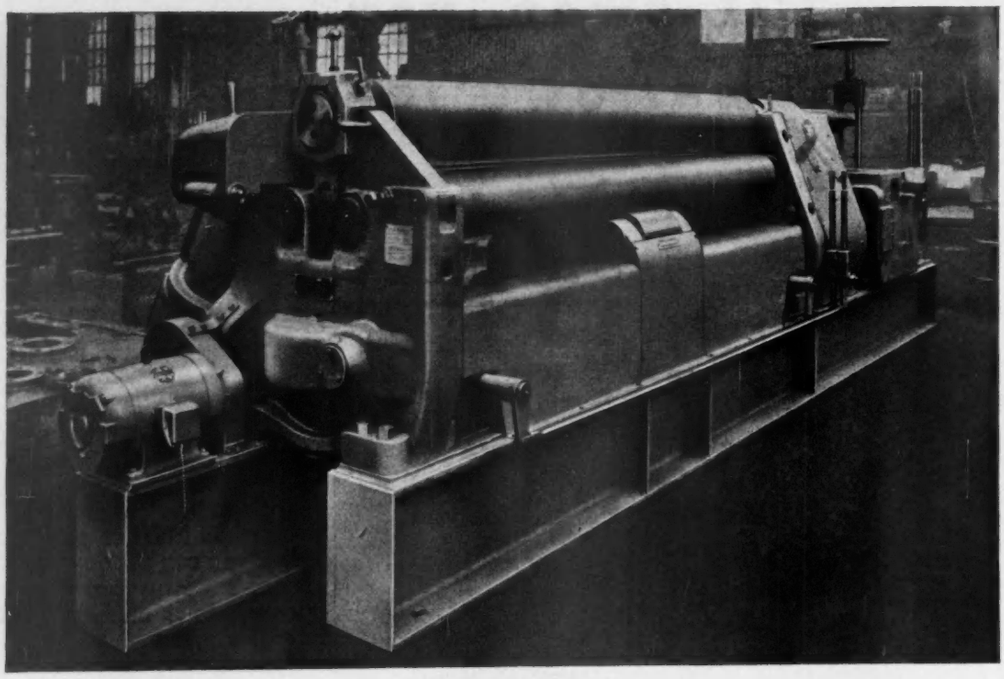

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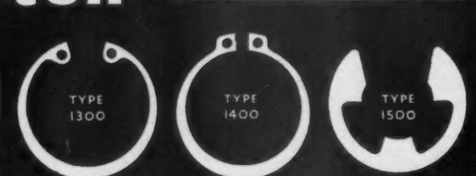

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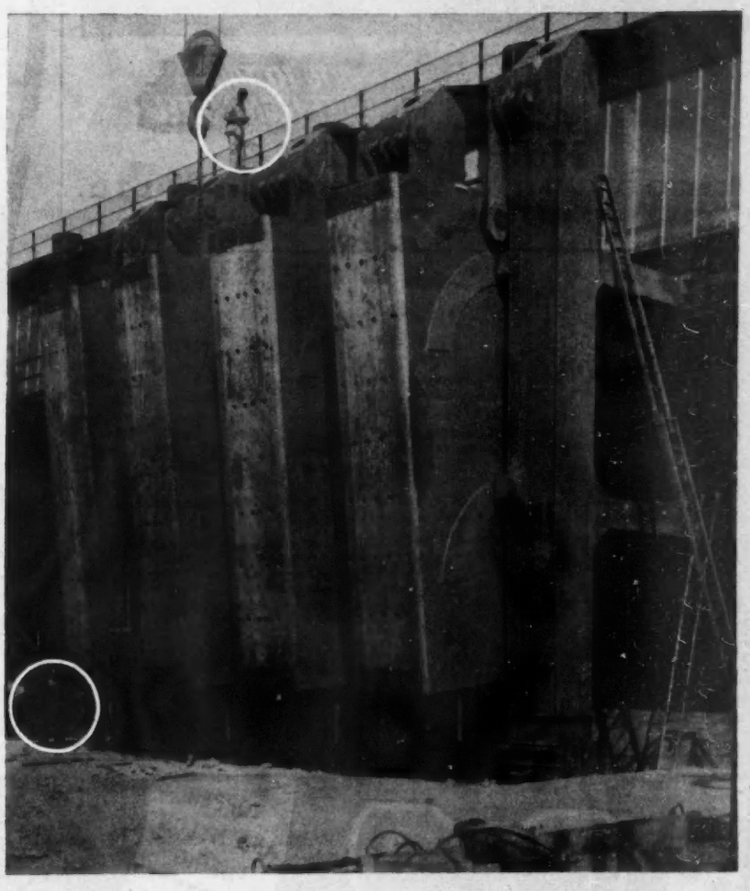

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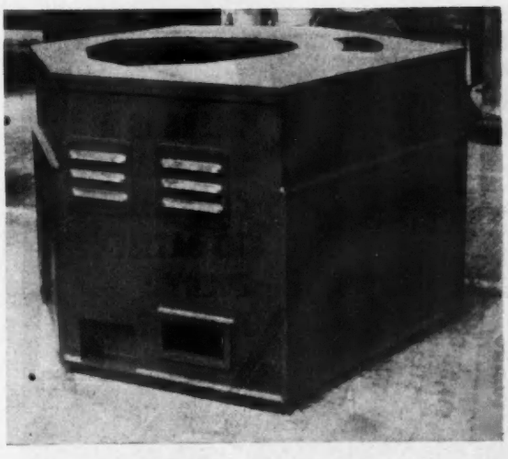

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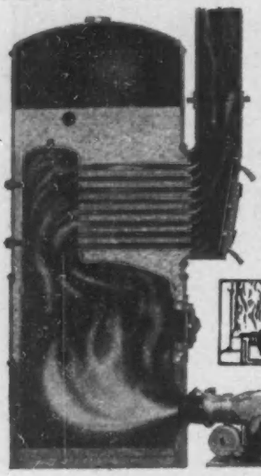

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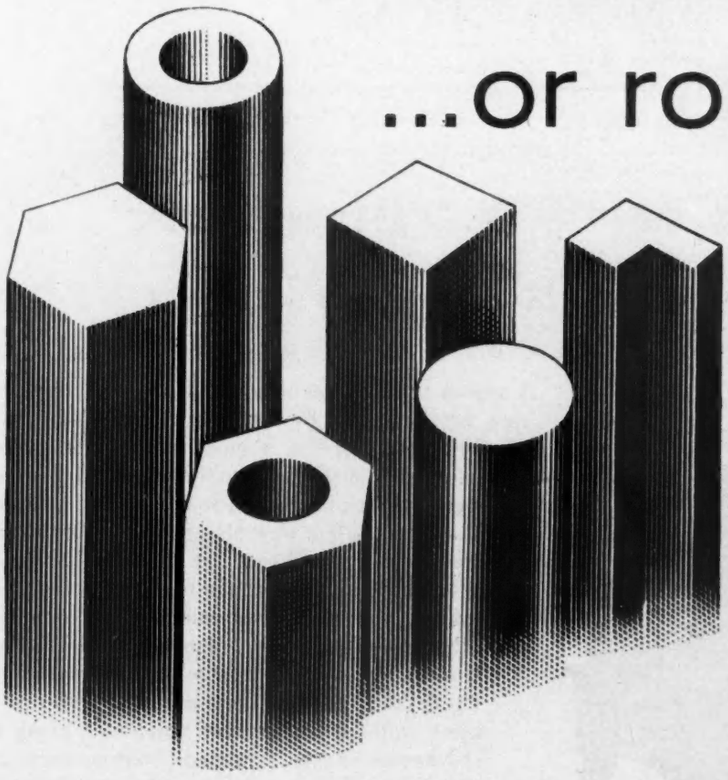

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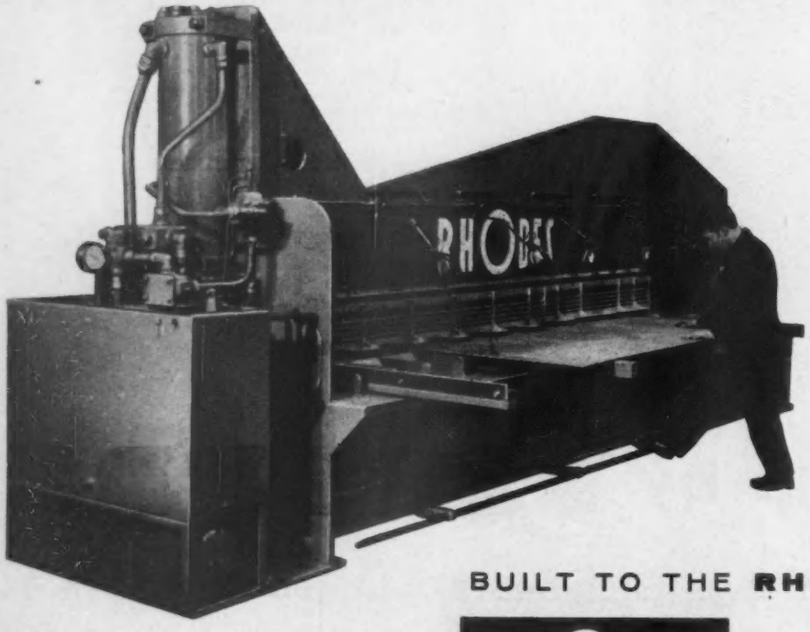

It seems to have become a habit to describe any new machine as "Revolutionary" —the word has lost its meaning— and most of these so-called revolutionary machines are the same old designs with a gimmick tagged on to them. This puts us in a quandary. For how else should we describe the Hydraversal Shears? It does the work of 5 machines, costs less than one. You can get rid of your plate shears, cropping shears, trimming shears, billet shears, slab shears — the Hydraversal will do all their jobs better than they did it themselves. Trim a sheet or crop a billet—without adjustment. You can't break it. The secret is the patented "reverse-scissor" action. Revolutionary? Just a gimmick? Or, as we believe, a matter of intelligent simplification? Plus know-how—136 years of it.

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There is no proven method of casting that is not within the scope of the division's resources. There is no recognised technique of testing that is not used at Penistone. Inspection by X- and gamma-radiography, by photo-electric absorptiometer and by spectrograph, are standard. Electromagnetic flaw detection is applied to all steel castings for aircraft and other special applications.

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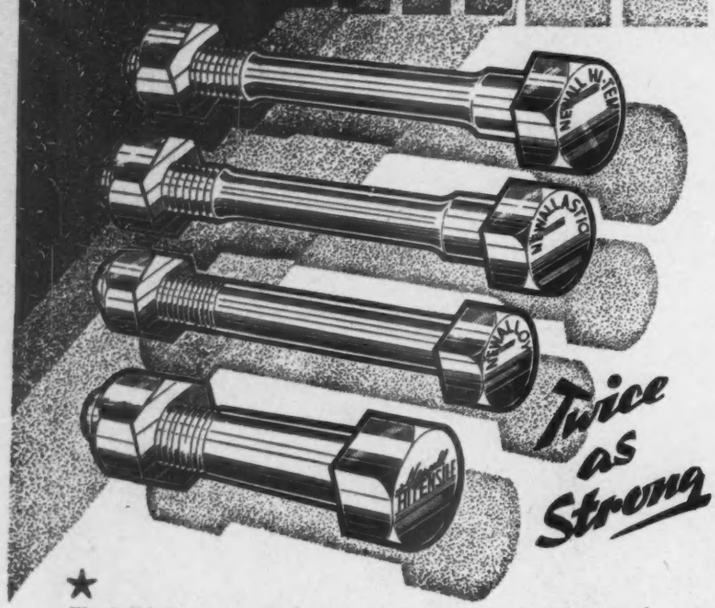

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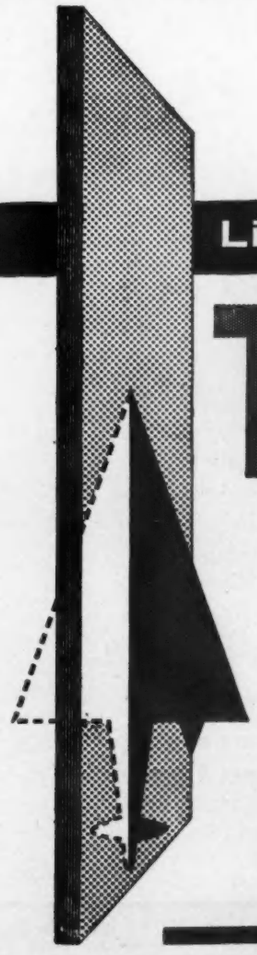

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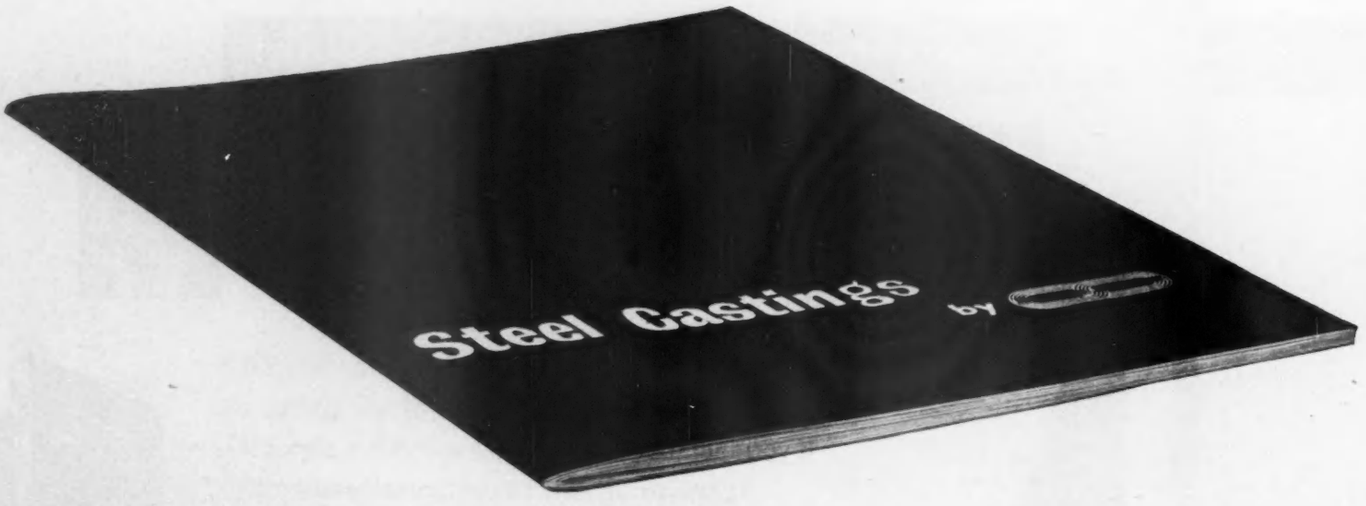
It is also a booklet of which you will want more than one copy; Design Engineers, Draughtsmen and Purchasing Officers all will find its contents of value to them. Copies will be sent free of charge and postage paid, in response to requests from Companies, and individuals who give the name of their Company.

A great deal of work has gone into the preparation of this booklet, and we wish only bona fide users to send for it—but engineering students are also invited to send for a copy, and of course, copies are available to technical colleges and other training institutions which serve the engineering industries.

Please write for copies to:— Brown, Lenox & Company Limited, Pontypridd, Glamorgan.



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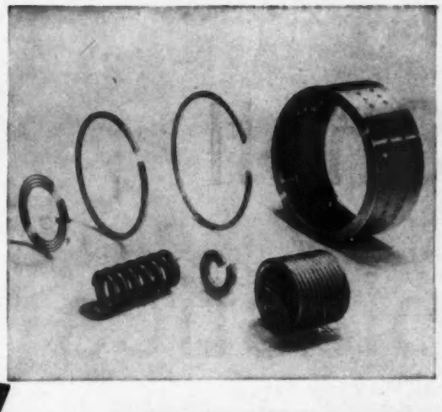

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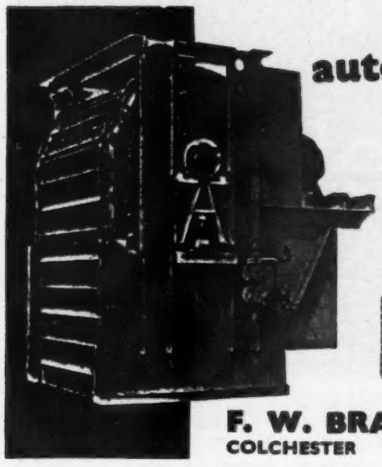

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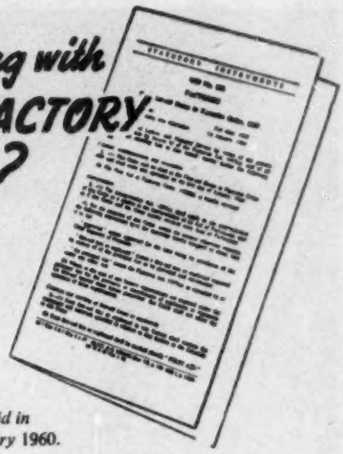

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All those who are interested in furthering the standard of design in the plastics field are invited to enter.

Entry forms and a wallet containing details of the properties of these two materials are available from our Plastics Division.

Prizes will be awarded for the design of an article or appliance for the industrial, domestic, institutional or public services market which could, with advantage, be made wholly from or incorporate a major proportion of either Shell Polypropylene or Shell High Density Polyethylene.

Closing date for entries 30th June, 1960.

The competition will be judged by:

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Mr. V. N. Luke, Manager, Plastics Division,
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Mr. Paul Reilly, Hon. F.S.I.A.,
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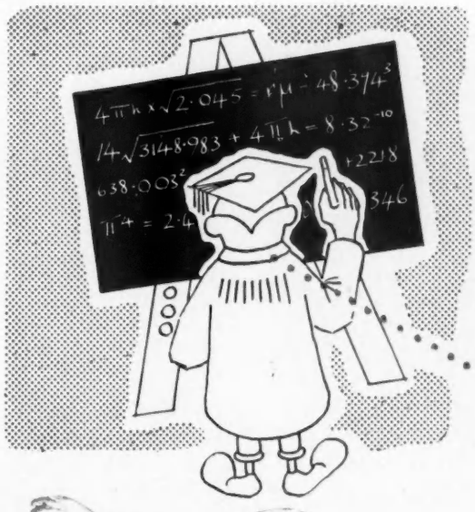

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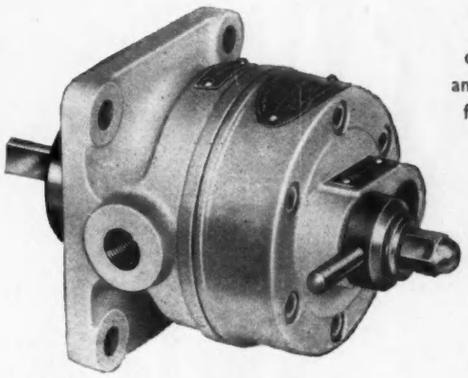

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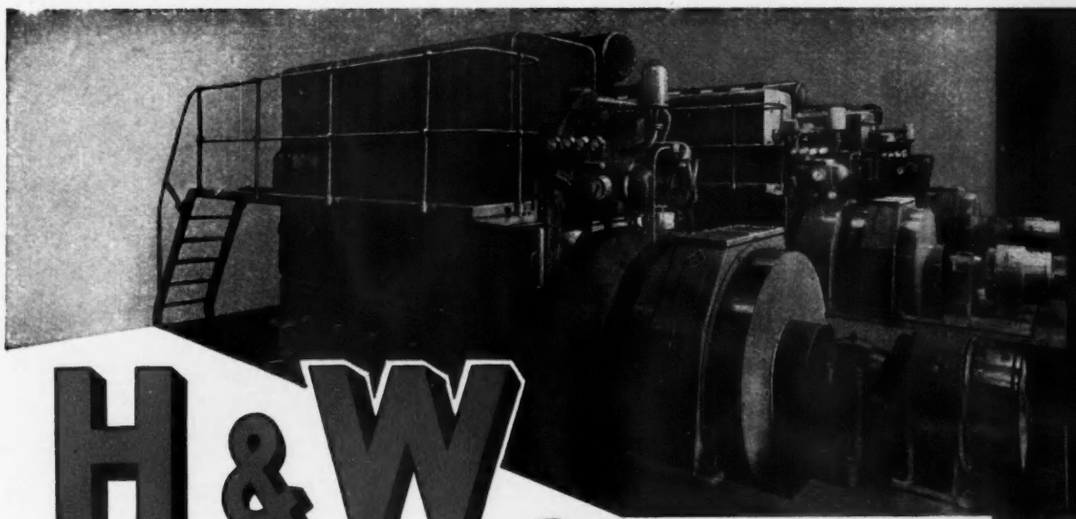

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Alternators and engines are of H & W design and manufacture thus ensuring our undivided responsibility for the complete power set. We also supply the necessary control equipment.

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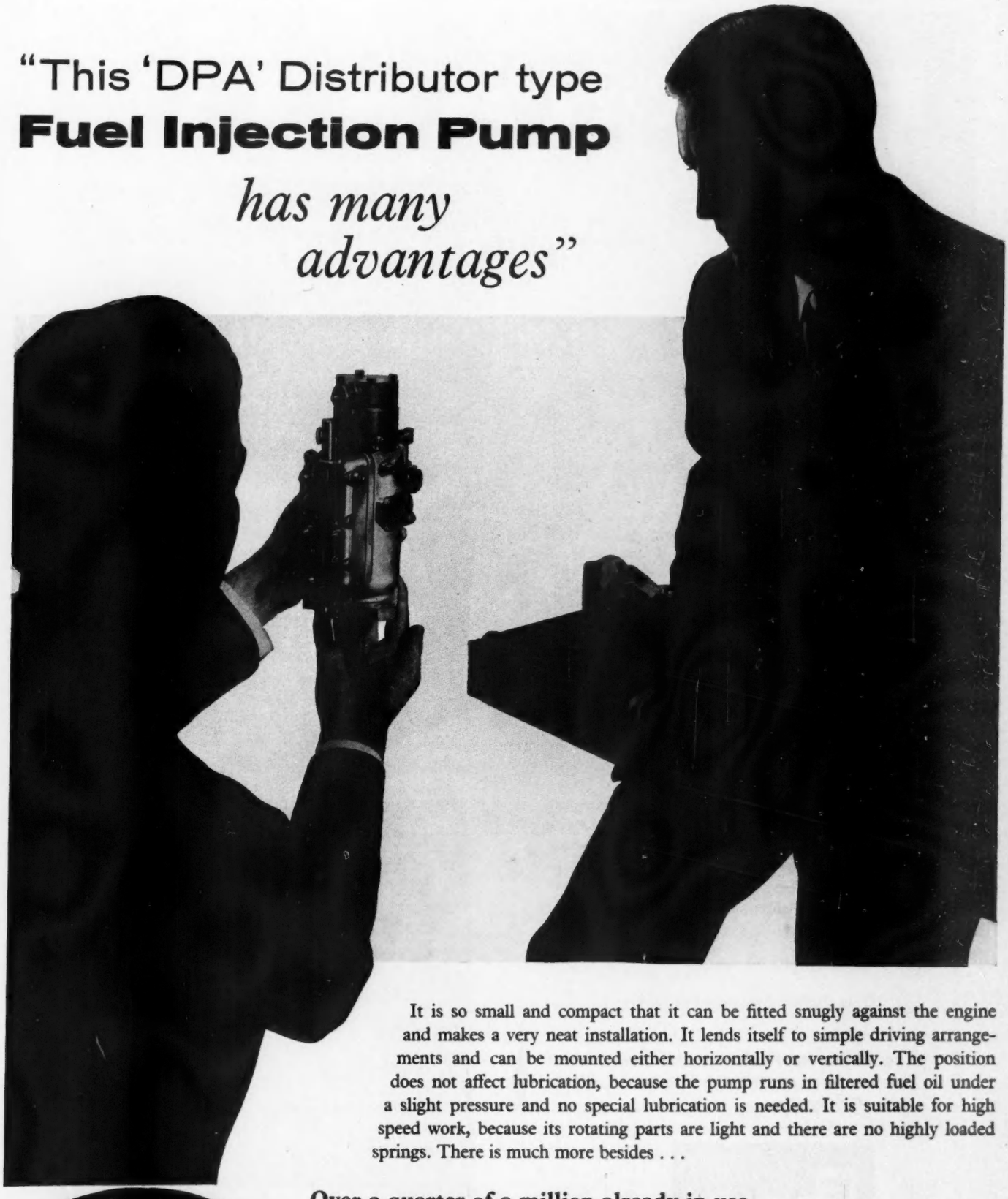
Fuel Injection Pump
has many advantages"



It is so small and compact that it can be fitted snugly against the engine and makes a very neat installation. It lends itself to simple driving arrangements and can be mounted either horizontally or vertically. The position does not affect lubrication, because the pump runs in filtered fuel oil under a slight pressure and no special lubrication is needed. It is suitable for high speed work, because its rotating parts are light and there are no highly loaded springs. There is much more besides . . .

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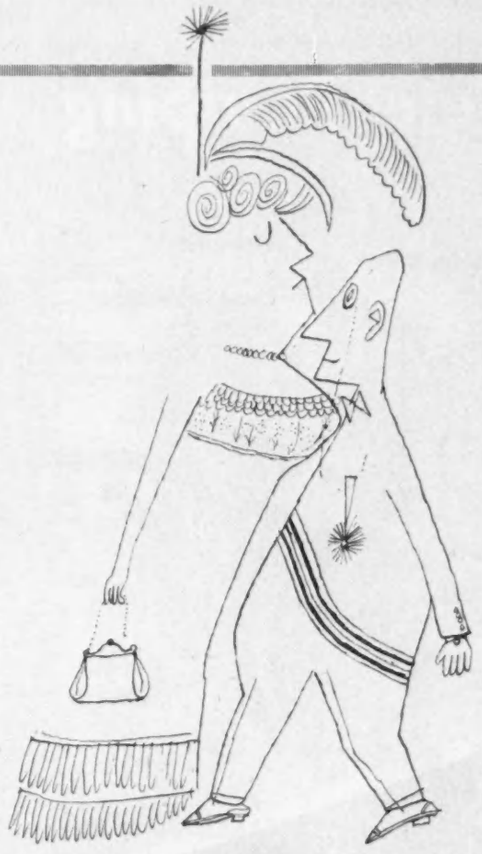

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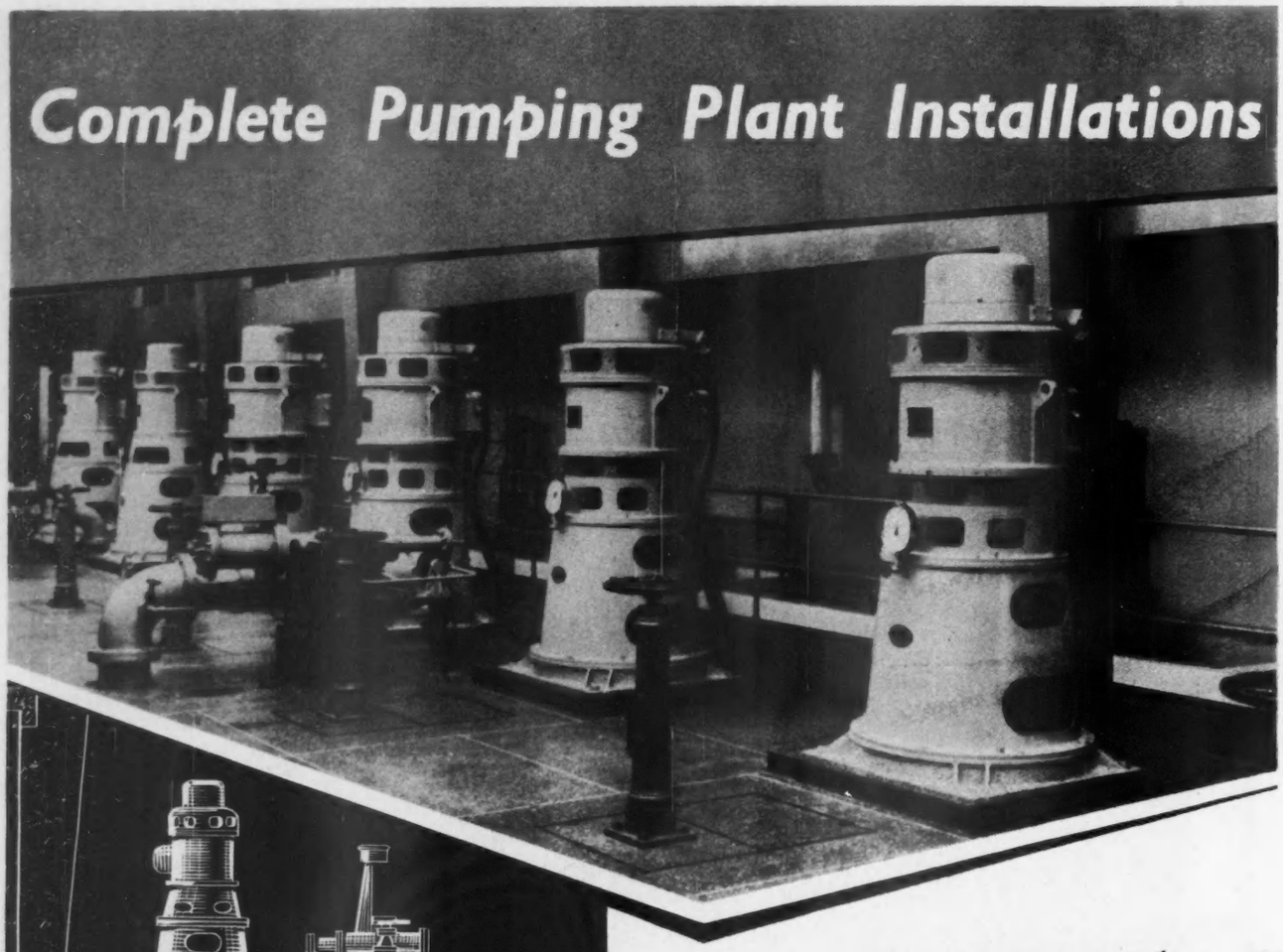

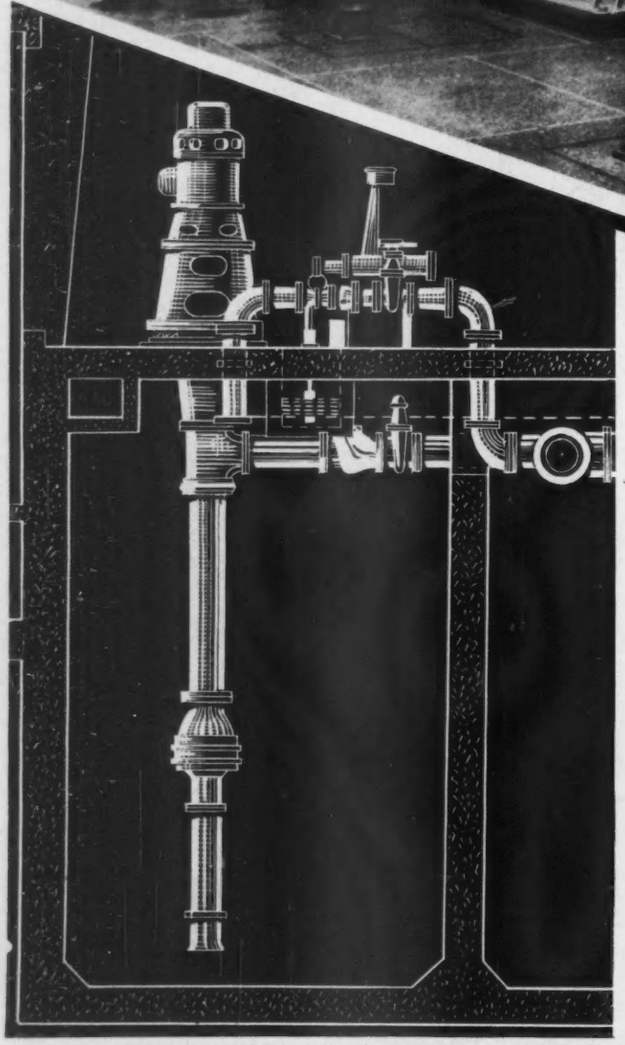

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In addition to the reflux and sluice valves, a Blakeborough Larner-Johnson surge suppressor is installed for the high-lift pumps, as shown in the illustrations.

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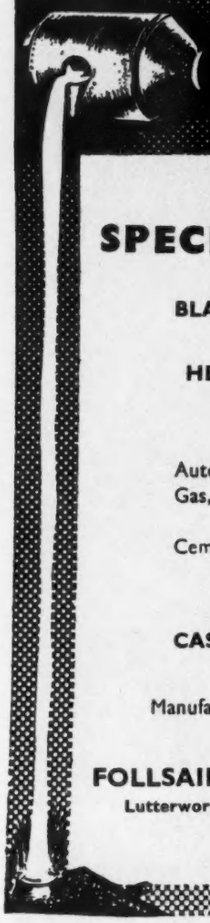

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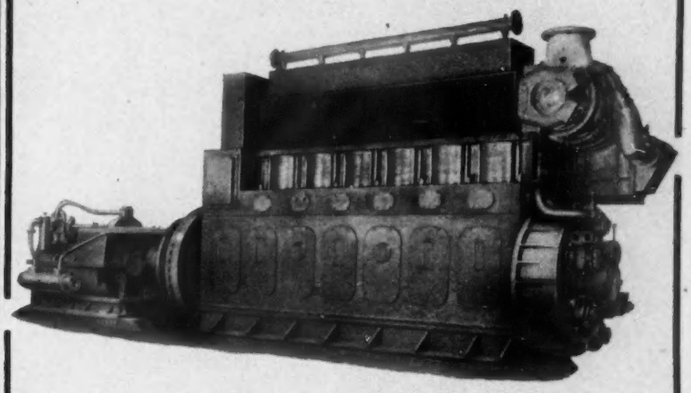
12,000,000 B.H.P. already installed.



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700kW pass-out/condensing STEAM TURBO-ALTERNATOR SET, generating at 6600 volts, 3-phase, 50 cycles supply, incorporating turbine by **Fraser & Chalmers,** designed for an initial pressure of 180 p.s.i., 420 deg. F., and for passing out up to 10,000 lb. of steam per hour at 30 p.s.i. Direct coupled through reduction gear to alternator by **G.E.C.,** complete with switchgear. Set has surface condenser cooling water pumps.

The above sets are still installed and are complete with all standard ancillaries, pipework, valves and gauges.

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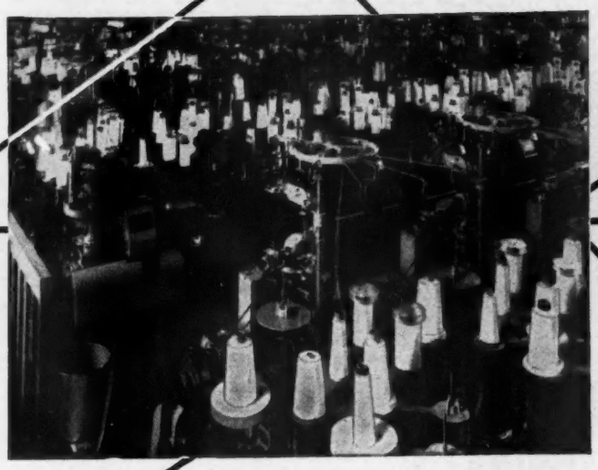

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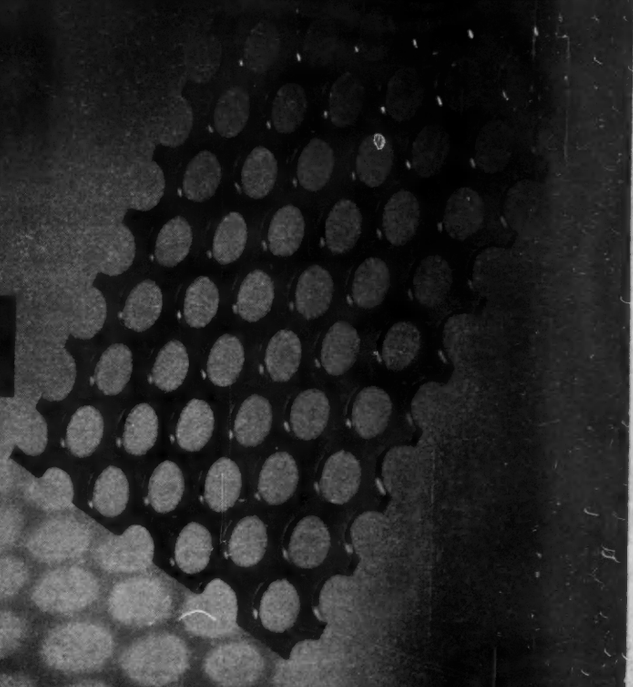

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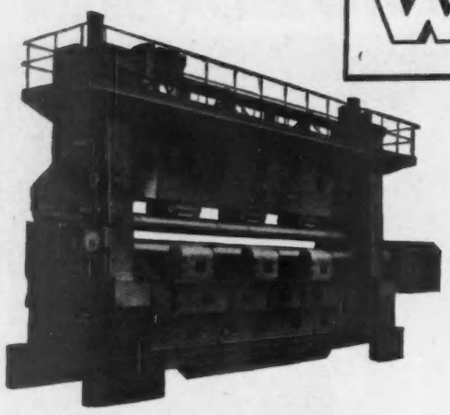

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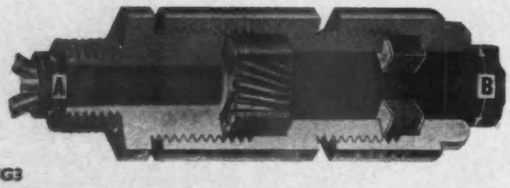
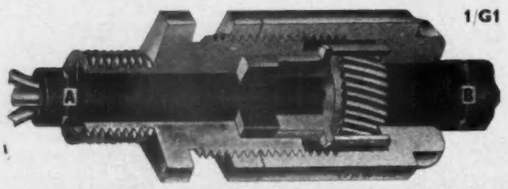


9/G3



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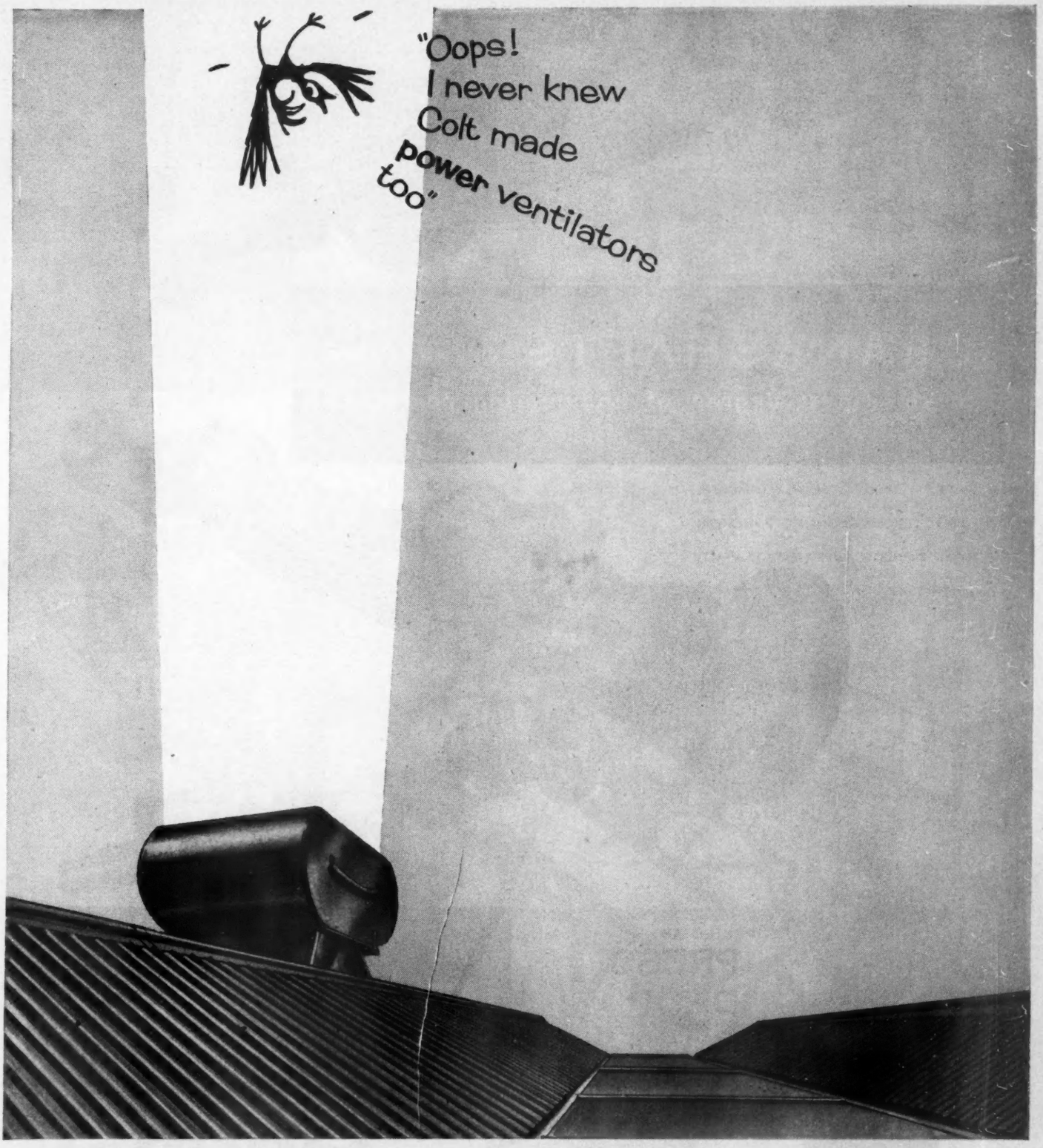

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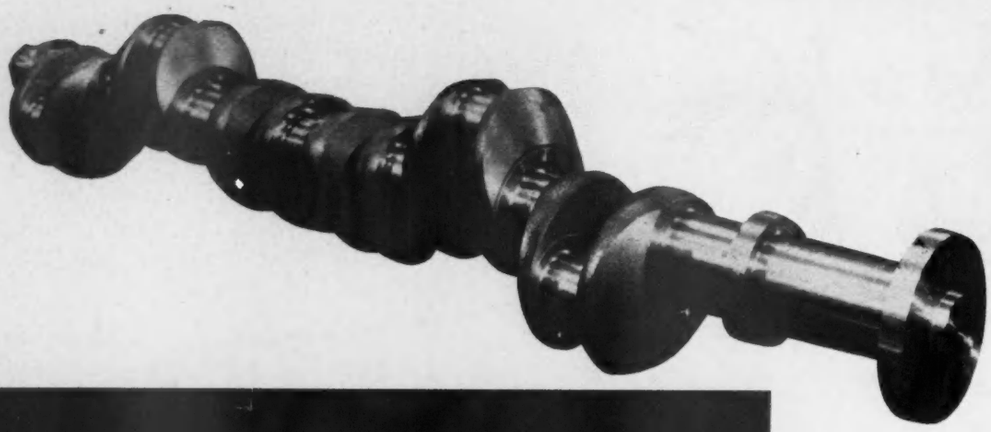

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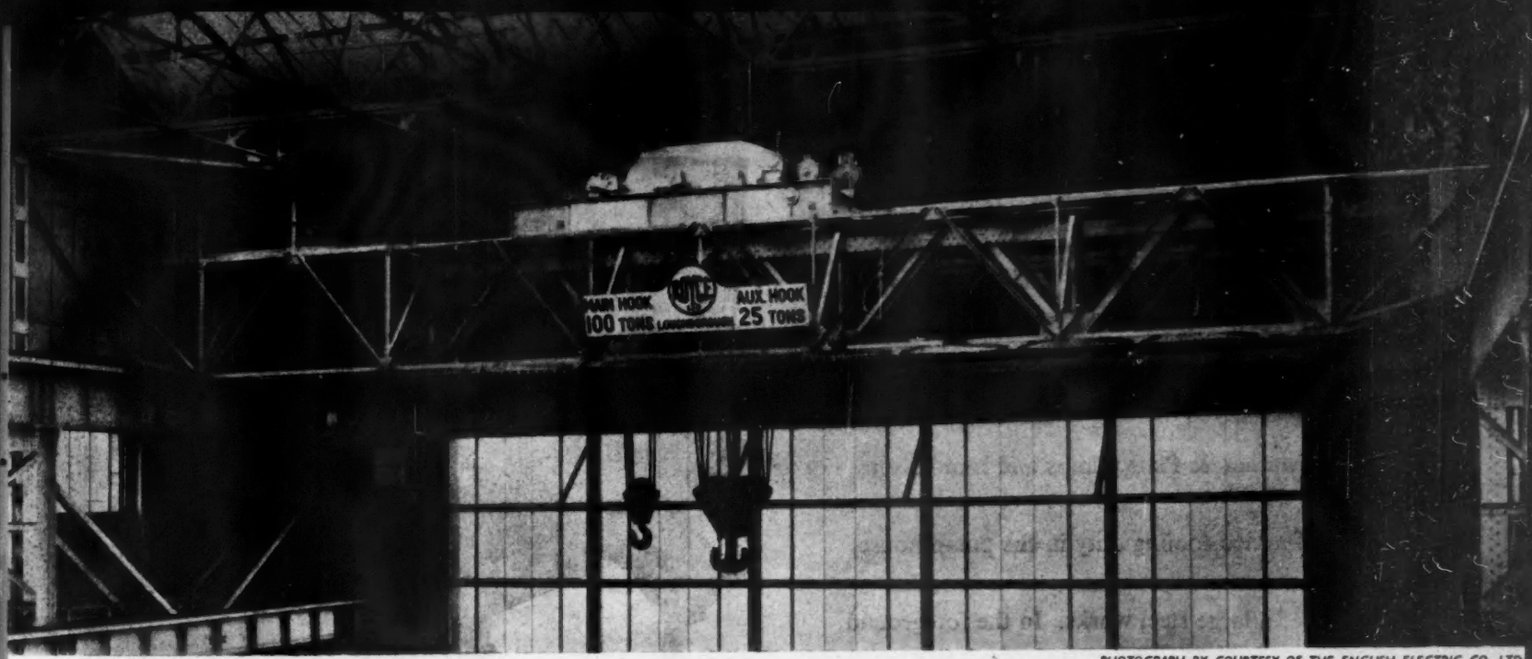

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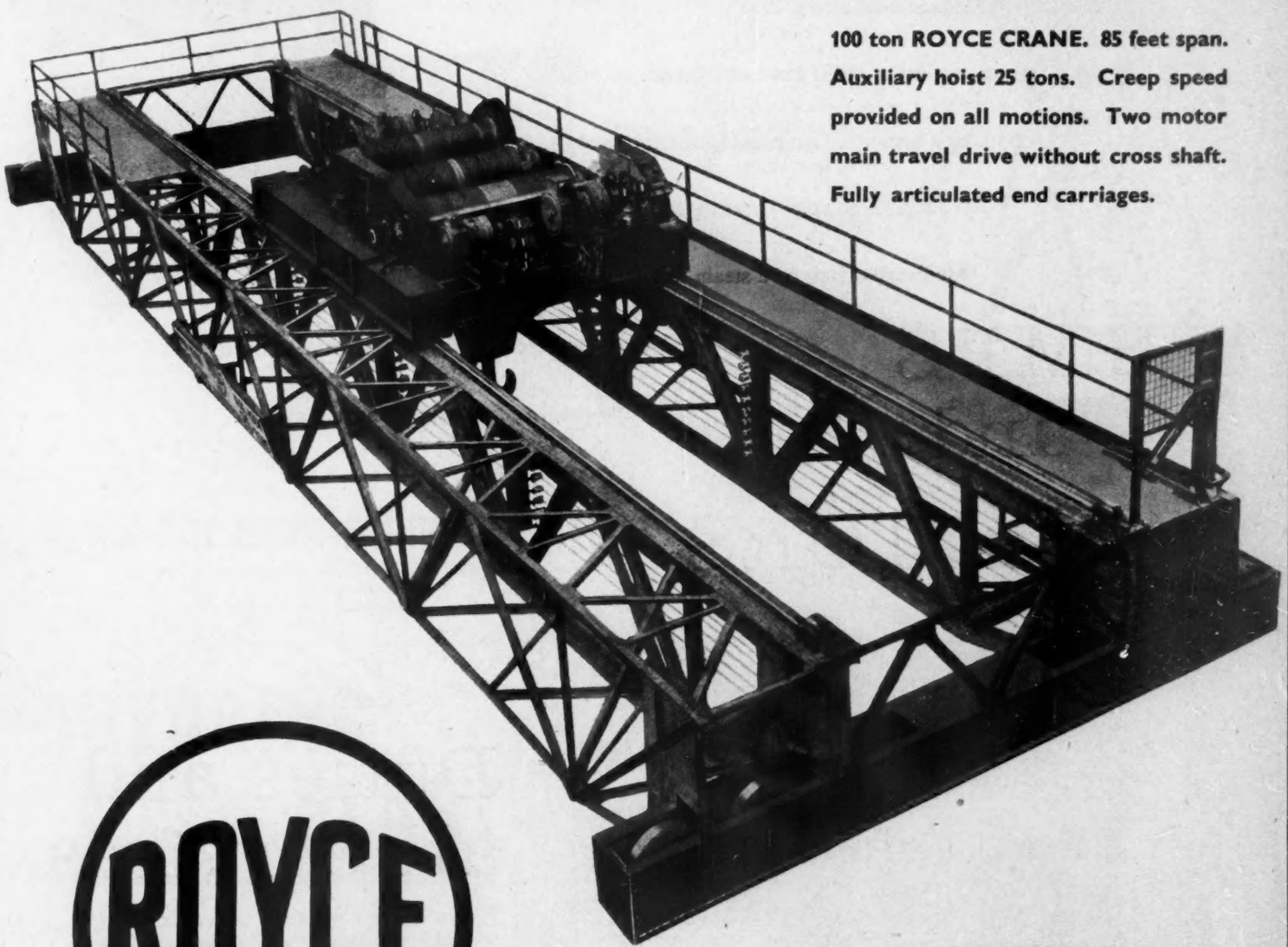

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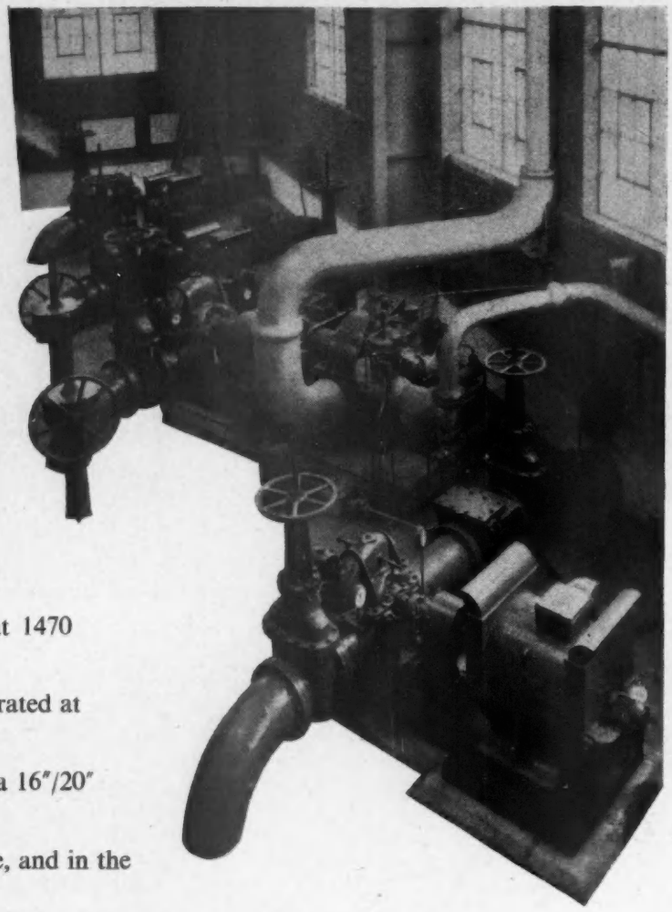

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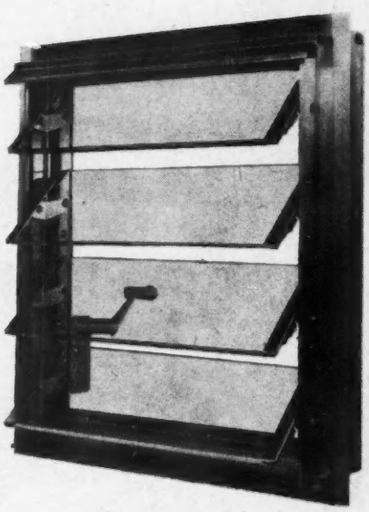

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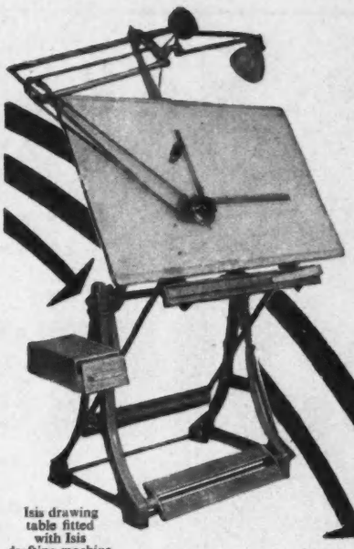

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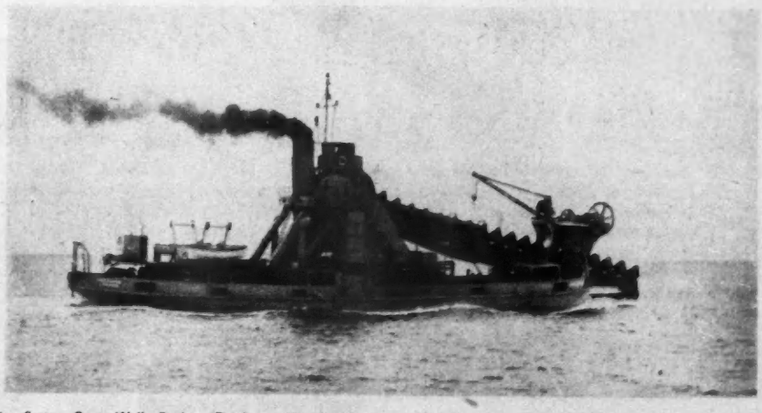

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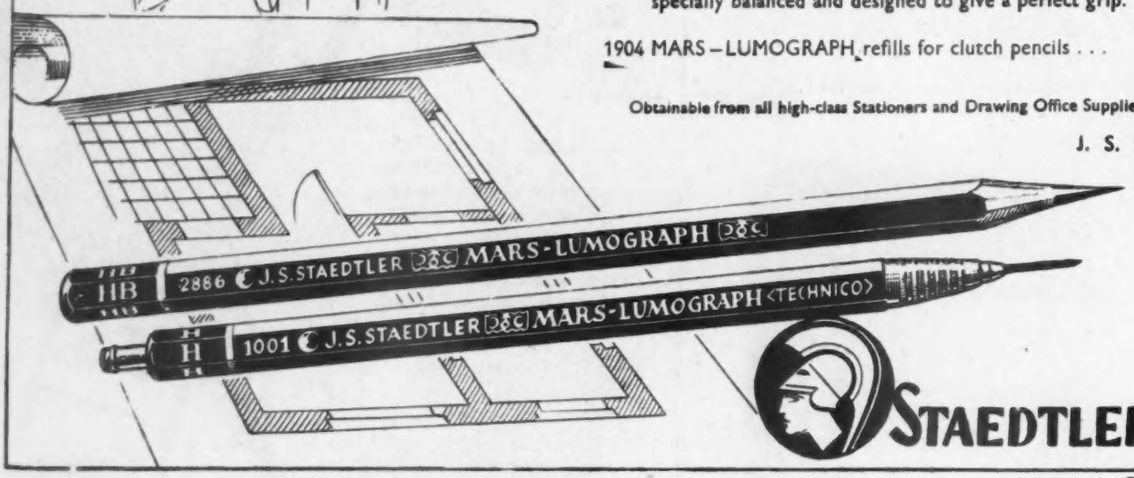

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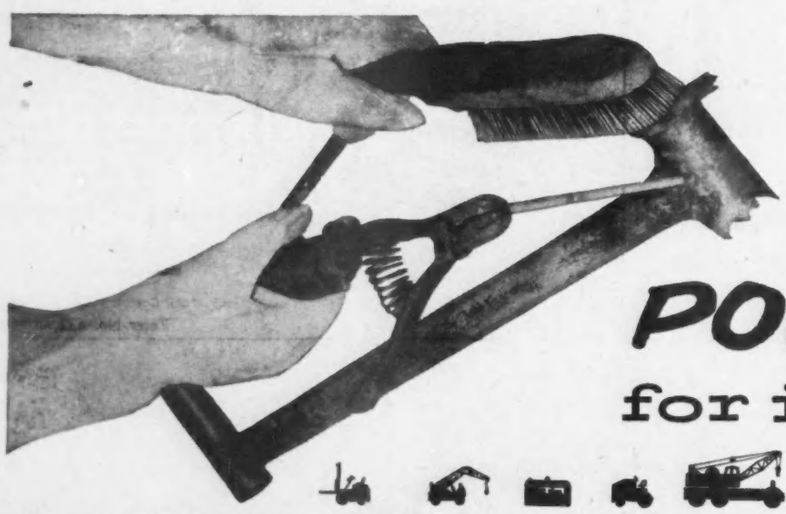

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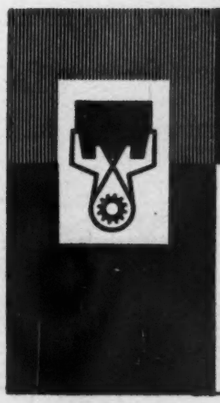

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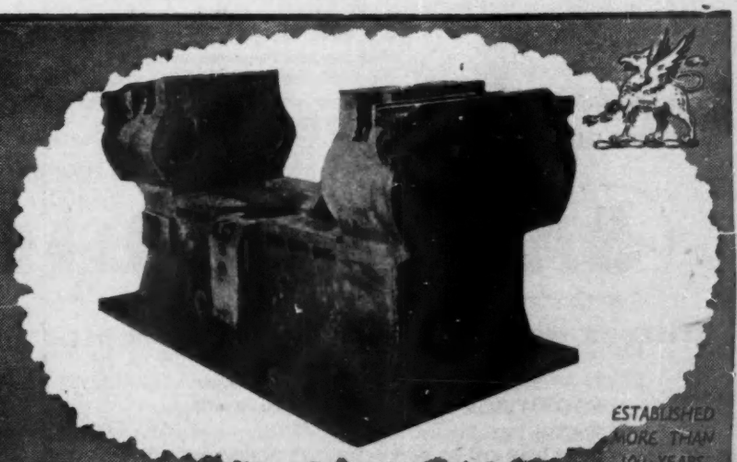

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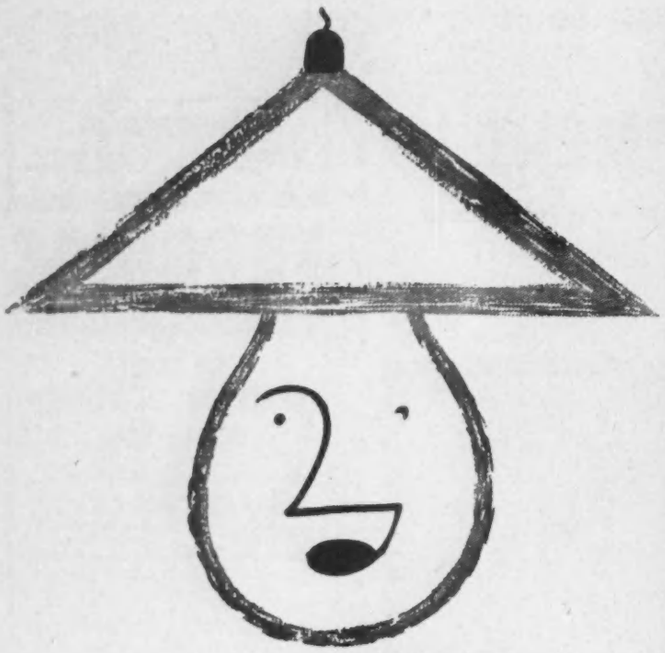

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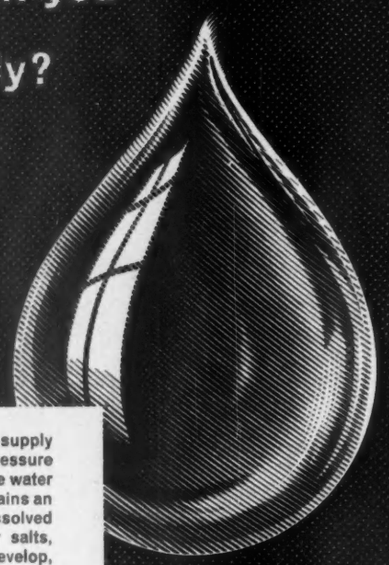

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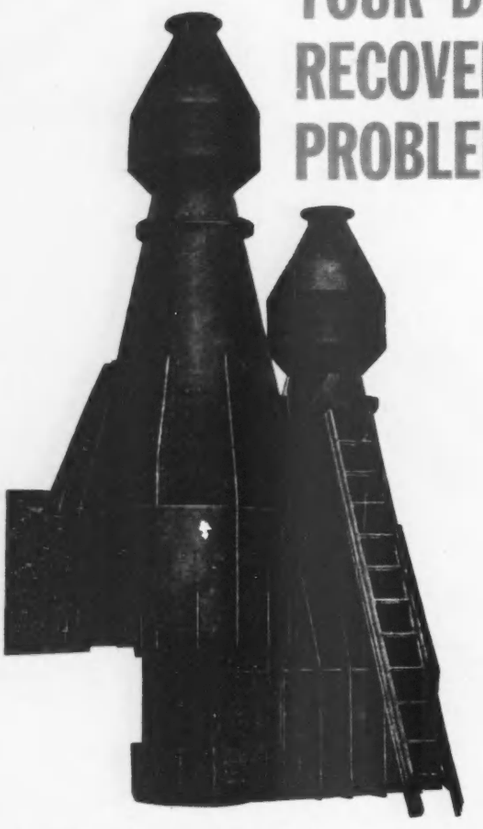

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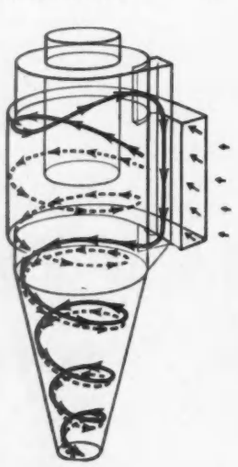

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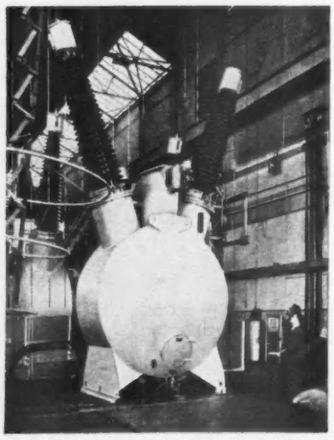

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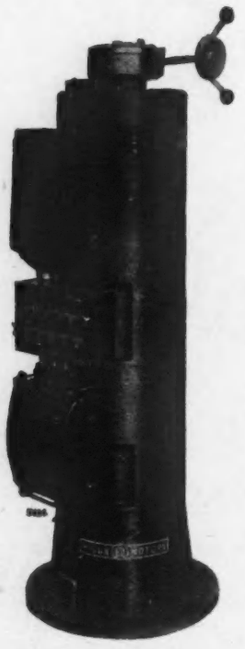

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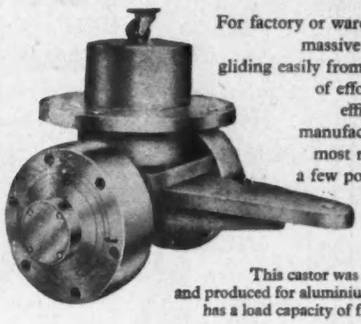

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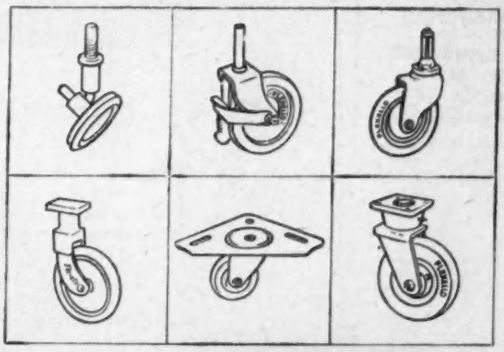

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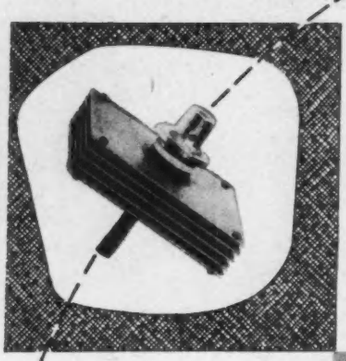

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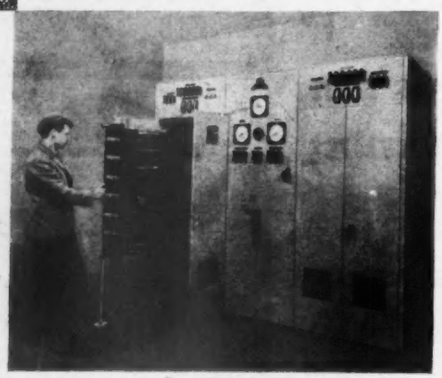

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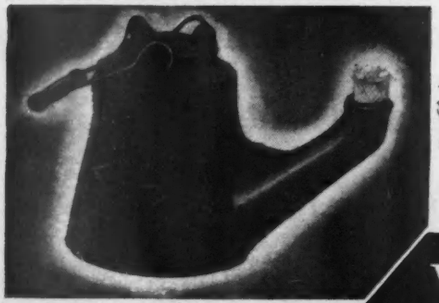

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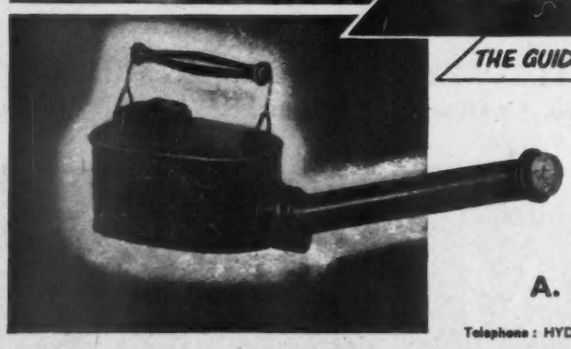

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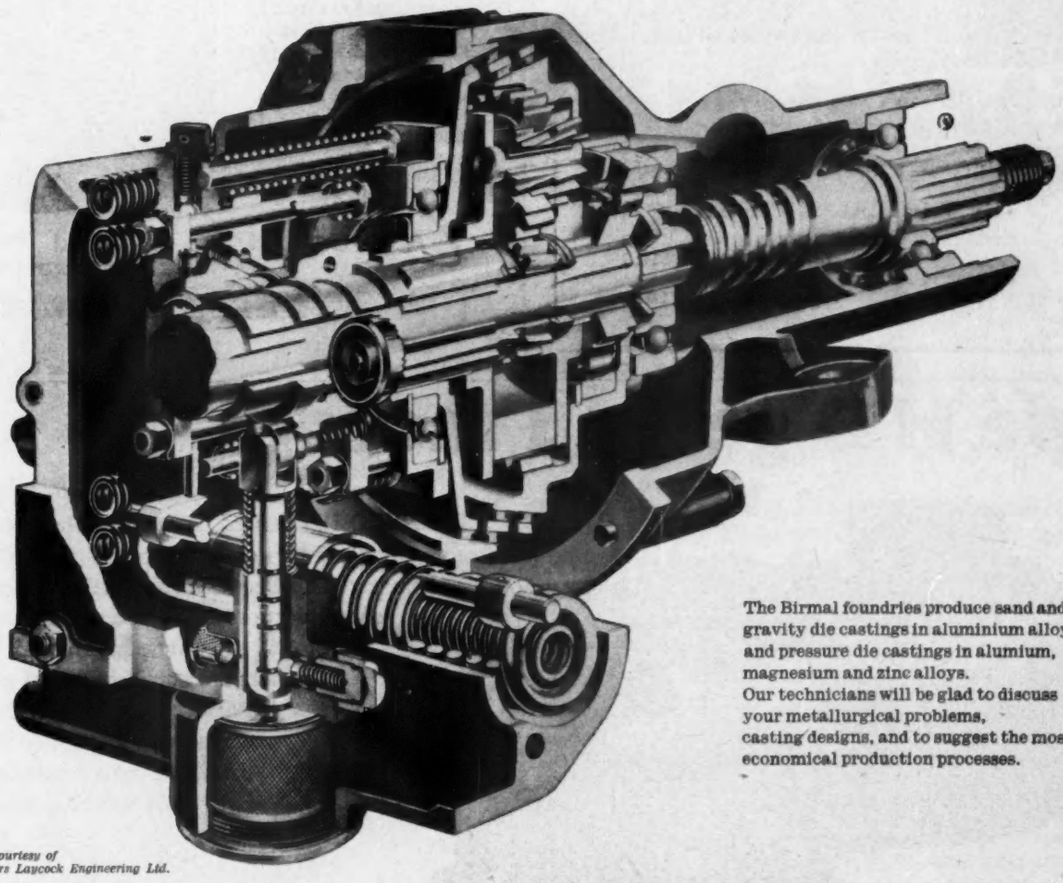

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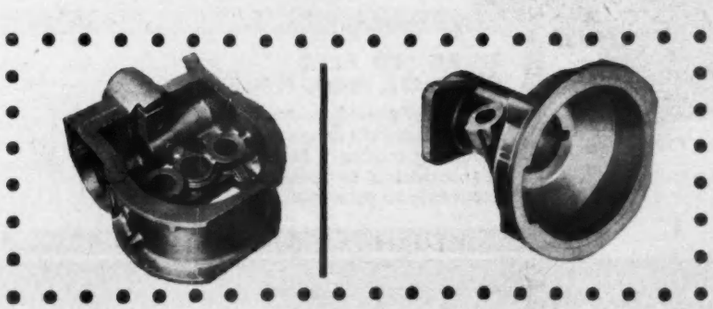

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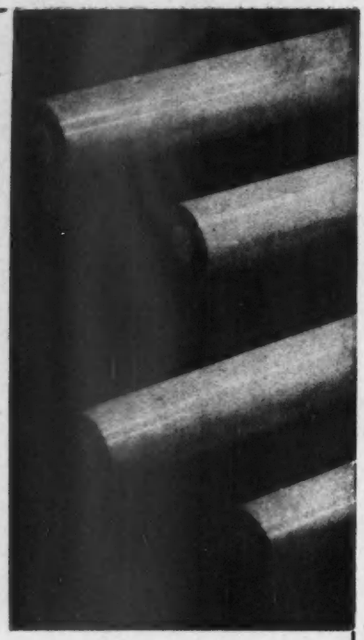

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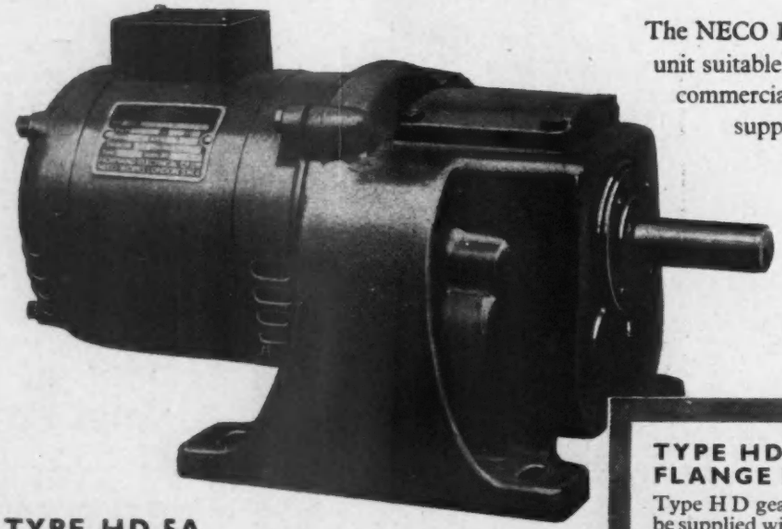

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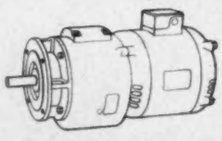

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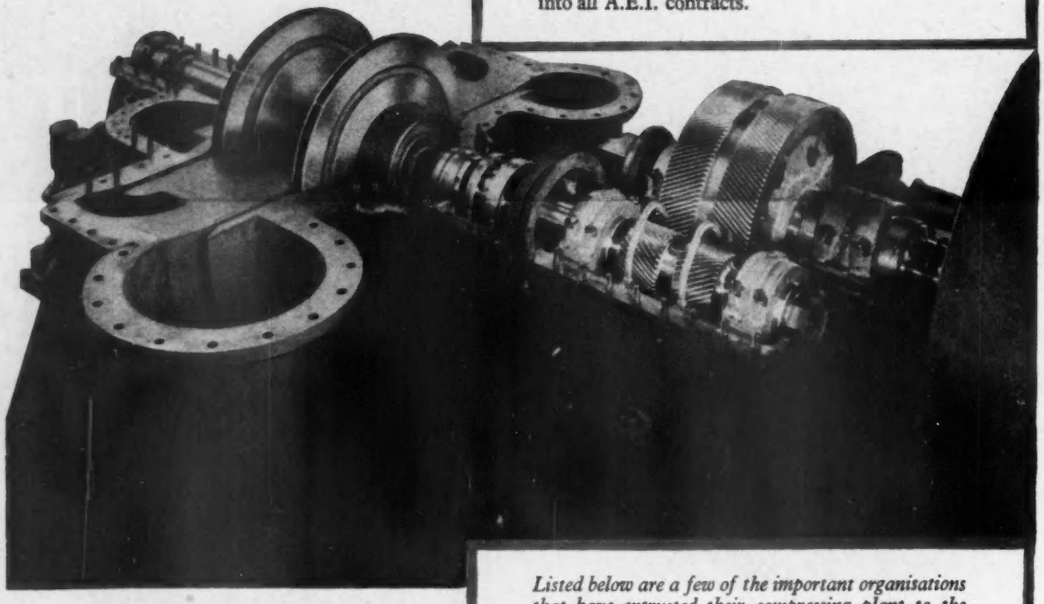

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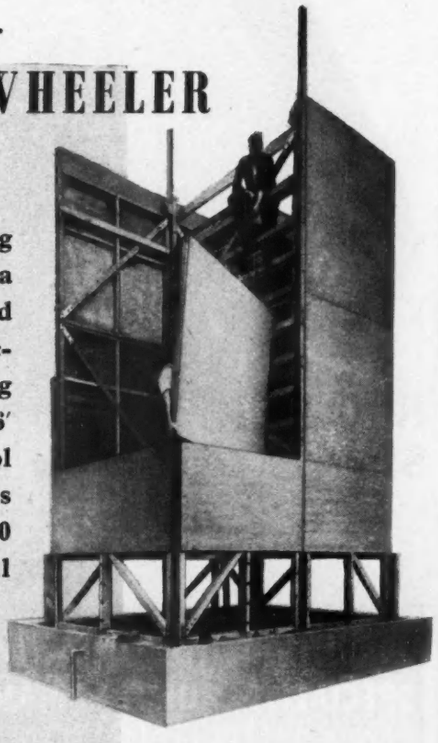

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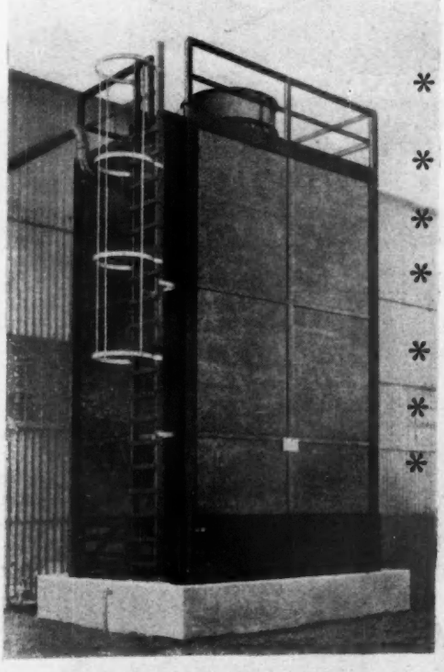

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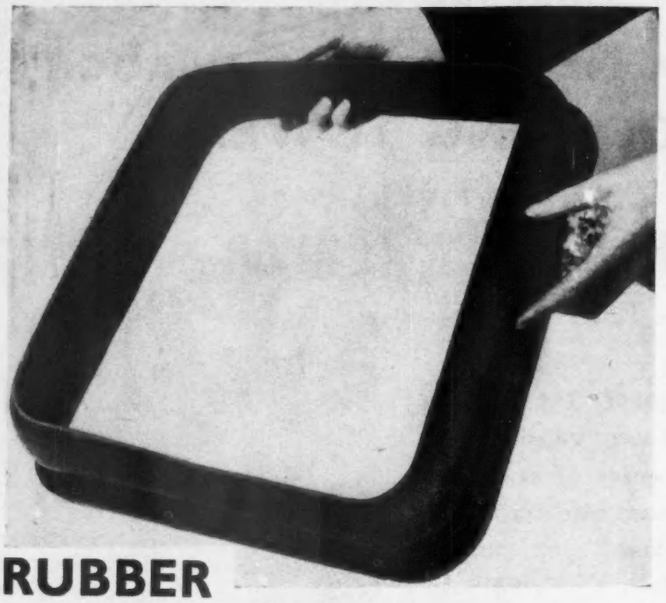

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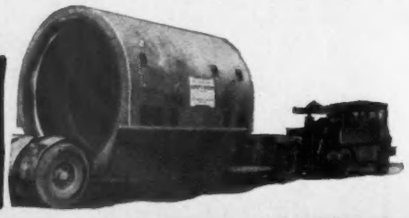

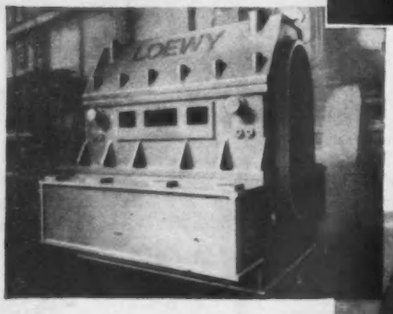

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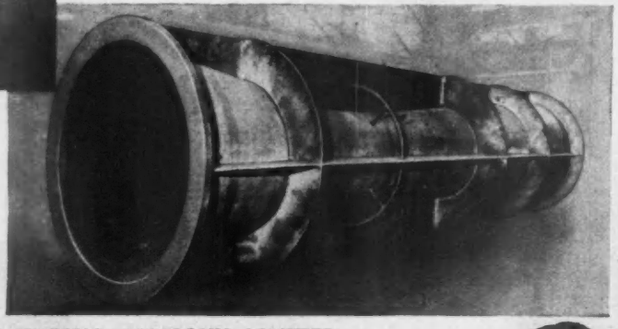

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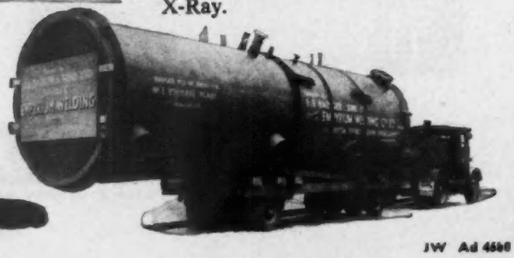

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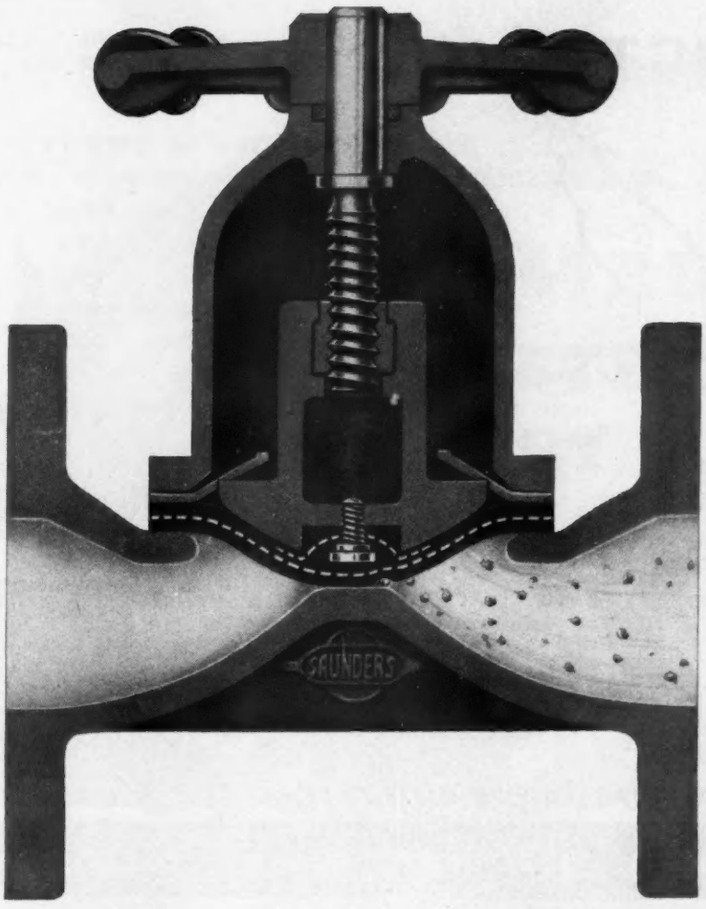

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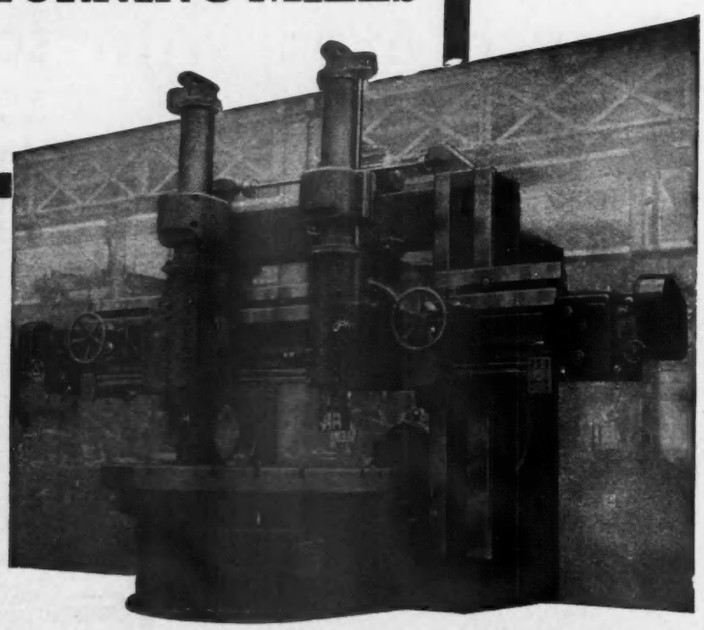

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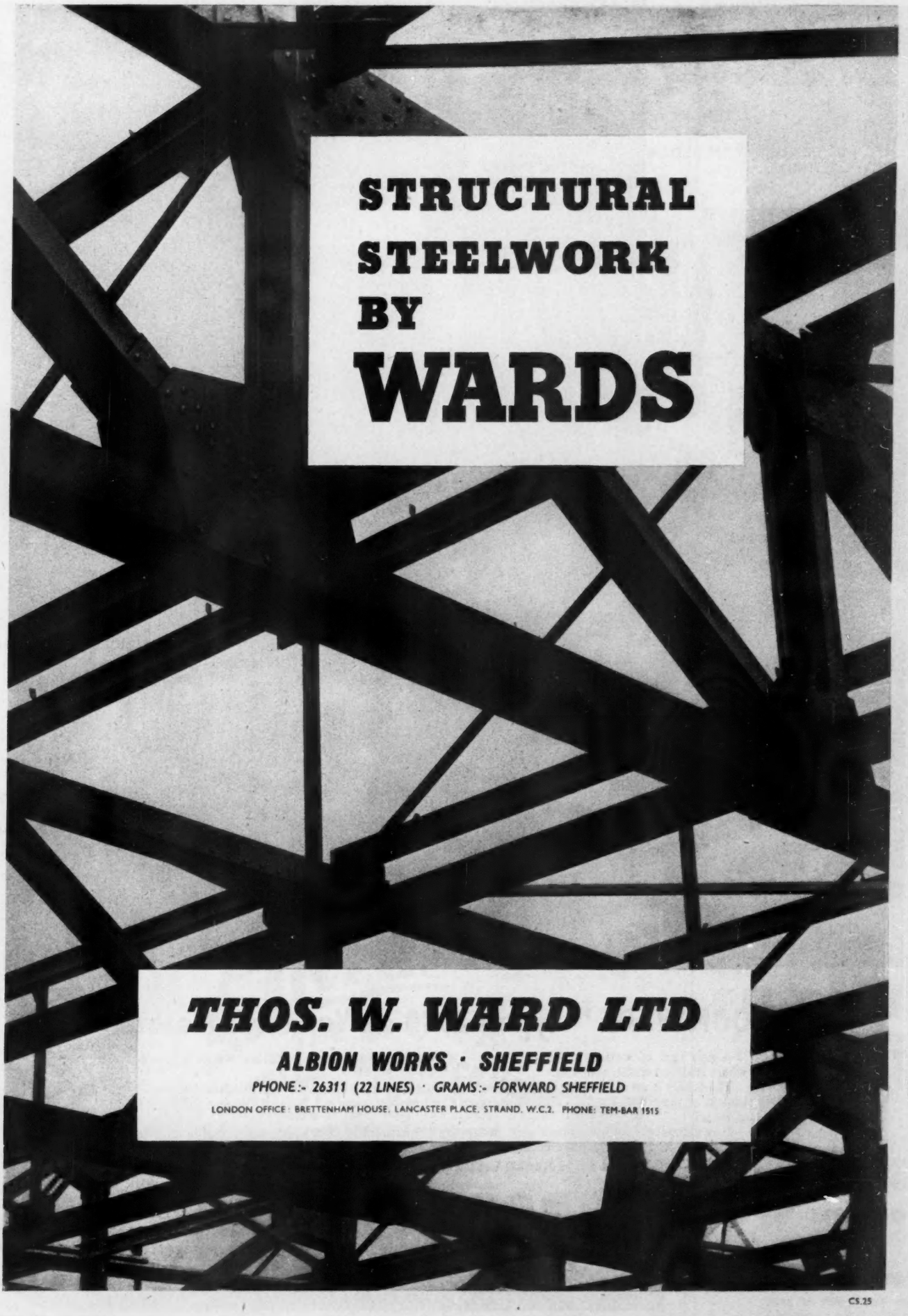

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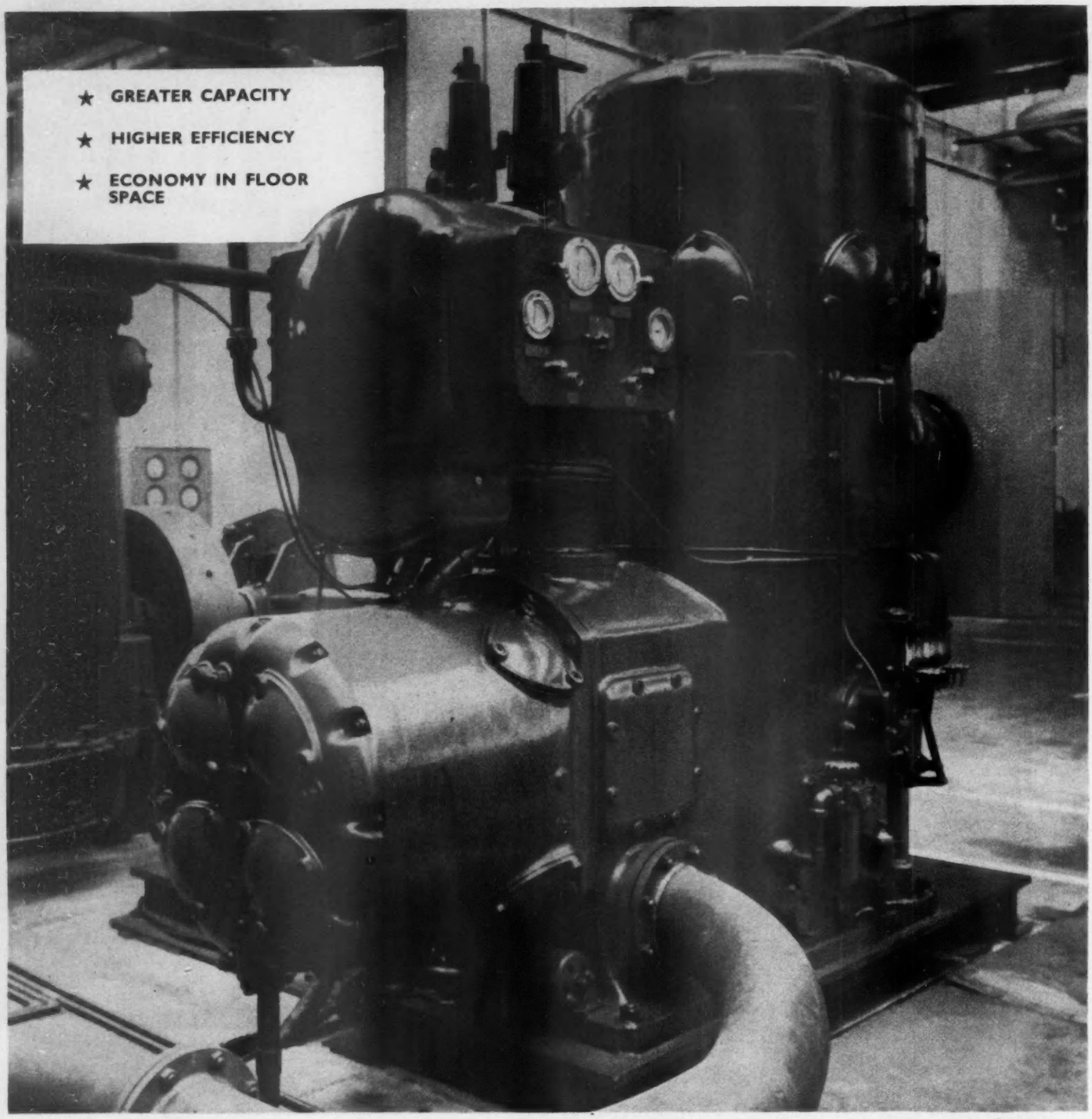

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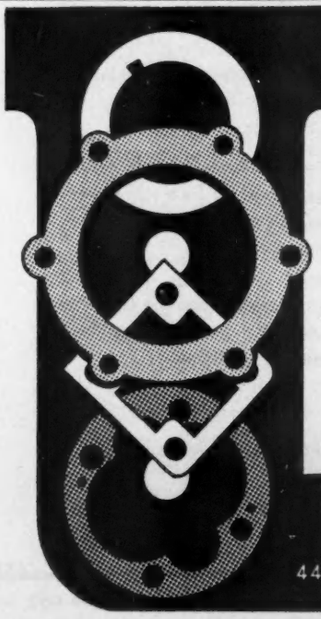

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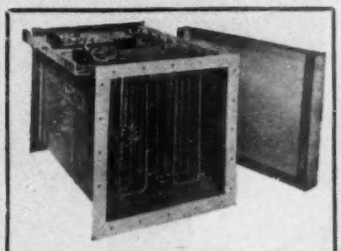

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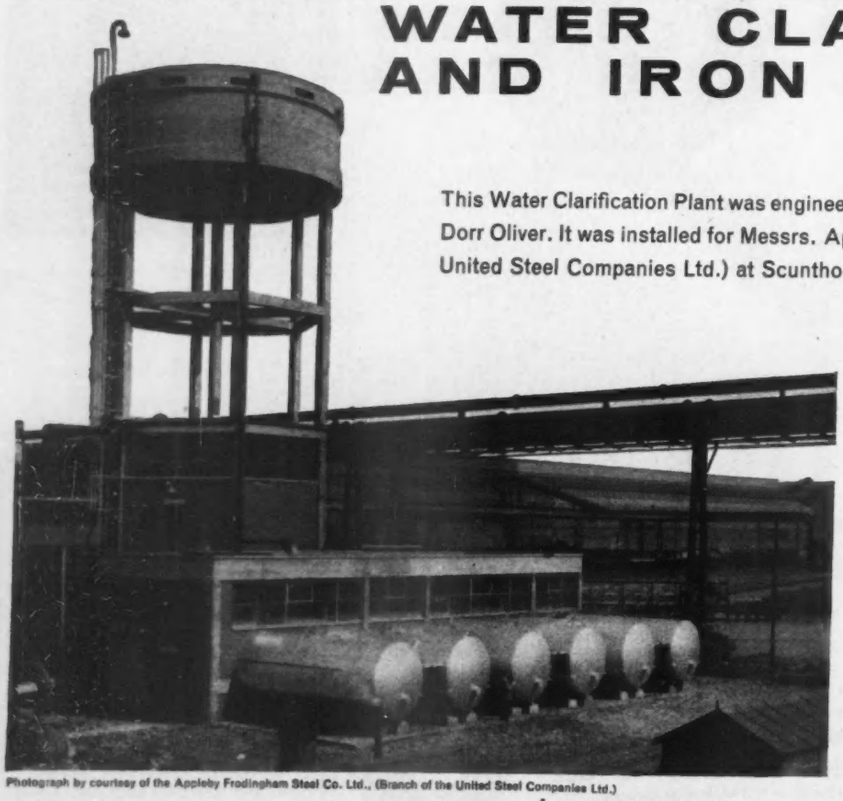

Photograph by courtesy of the Appleby Frodingham Steel Co. Ltd., (Branch of the United Steel Companies Ltd.)

This Water Clarification Plant was engineered by Lodge-Cottrell in collaboration with Messrs. Dorr Oliver. It was installed for Messrs. Appleby-Frodingham Steel Company (Branch of the United Steel Companies Ltd.) at Scunthorpe, and enables them to re-cycle the rolling-mill water. A large part of the total flow is cleaned through sand filters to leave approximately 1 part per million of solids. Secondary filtration of the thick slurry, taken off as underflow from the Clarifier, is also provided.

Another Filtration Plant, similarly engineered, has been in operation for three years at the Ebbw Vale Works of Richard Thomas and Baldwins Ltd. It recovers solids with an iron content of about 35%.

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THE ENGINEER

No. 5429 FEBRUARY 12, 1960 VOL. 209

"MECHANICALS" MEETINGS

We see from the current issue of the *Chartered Mechanical Engineer* that the Institution of Mechanical Engineers plans to alter the structure of its meetings. To date papers have been accepted by the Institution for presentation at headquarters and publication in the *Proceedings* ; and by the Branches for presentation in the provinces usually without publication. The consequence has been that ordinary meetings have tended to be held almost every week at headquarters during the winter months and less frequently by the Branches. Now it is planned that some of the ordinary meetings of the Institution at which "headquarters" papers are presented shall be held at the Branches, particularly when the subject of a paper is likely to be of special interest within a Branch area. As a consequence of this arrangement the number of ordinary meetings held in London will be reduced to about two per month and at half of these meetings it is planned that memorial lectures, addresses, and "review" papers shall be presented. There will also be presented certain more specialised papers, no doubt those having no special relevance to the work of engineers in any given geographical region. More room within the programme will become available for informal discussions at headquarters, which have proved popular and valuable, and for the holding of evening symposia. It is also proposed that symposia extending over a whole day or more shall be limited to two in each year.

The fact that the Institution has thought it desirable to alter the structure of its meetings is an indication of the very substantial change in its affairs which has come about in the last quarter of a century. Twenty-five years ago headquarters meetings held once a month were ample to cover the ground ; and a quite large fraction of the audience attended every meeting since the papers, though technical, appealed to almost all kinds of mechanical engineers. But nowadays even a meeting every week is proving insufficient. Those meetings have to be supplemented by the organisation of symposia and the publication of a substantial number of papers for written discussion. Furthermore papers have become increasingly specialised so that the audience at each meeting tends to be confined to specialists too.

Many older engineers will look back nostalgically to a past when the Institution was smaller and its society more intimate. But one can never go back. As the Institution moves into the future its present planning should appeal to its members as wise. For it is surely sound to make more use of Branch facilities and the exercise will provide a flexibility hitherto lacking in that, if necessary in the future, by holding meetings in the same week at different Branches more than one headquarters paper per week could be presented. Additionally—it is a point which specially appeals to us if only because we cover a field very much wider even than that of the Institution—more room, it appears, is deliberately to be made for the presentation by notable men of reviews of the work going forward in their fields; reviews not intended for specialists but to keep mechanical engineers in general up to date in knowledge of such advances. For however much it may become fragmented into specialised fields there still remains, we are convinced, a unity in engineering thought and experience so that advances made by specialists in one field are likely to be applicable in several others.

RUBBER AT THE SCIENCE MUSEUM

We had the pleasure last week of attending a little ceremony at the Science Museum in South Kensington. It was the handing over to the Museum of three large showcases in the industrial chemistry gallery, containing objects illustrative of the molecular structure of natural and synthetic rubbers, their production, compounding, and processing, the wide variety of products thus obtained and the important part they play in modern life. The display has been devised and organised by the Federation of British Rubber and Allied Manufacturers and made possible by the generosity of British manufacturers of rubber products ; makers of synthetic rubbers, compounding chemicals, processing machinery and components ; the Natural Rubber Development Board, representing producers of natural rubber ; and the National College of Rubber Technology.

The ceremony illustrated two factors which have an important and perhaps even a ruling influence upon the policies of the Museum. The paucity of space available was forcibly brought home to us. For rubber is so important a material in our civilisation, and the treatment of natural rubber and the synthesis of artificial rubbers are so technically interesting, that we could not help thinking that a display confined to three showcases was not very adequate to represent the work of one of the ten largest industries in this country. But in relation to the immense field now covered by science and technology—we have stressed more than once that the museum is misnamed since more of its exhibits are technological than scientific—and in relation to the amount of space available, even when an extension now approaching completion comes into use, three large showcases may well be about the right proportion. How deplorable ! The other point, which ought to be more widely appreciated than it is, is the dependence of the Museum upon industry for new exhibits and the rearrangement of older ones. In relation to its real needs we suspect the funds available to the Museum for the purchase of new exhibits must be derisory. For it should be noted that to lay out the present exhibit, small relative to those of certain other wealthy industries, the Museum was clearly very glad to have monetary support. We do not think engineers can really regard that situation as satisfactory. We are sure the Museum authorities would not accept from industry exhibits they regarded as quite unsuitable, nor allow an industry grossly more

space than its importance really justified. We are equally sure that no industrial association prosposing to present an exhibit would attempt to throw its weight about unduly in doing so. We are also sure that it is beneficial all round that industry should contribute at its own costs to the Museum's exhibits. But t:e real situation seems to be that the Museum authorities cannot move very effectively without the support of an industry and since some industries are likely to prove more generous than others and some may have no organisation through which such generosity could be organised there is necessarily a risk that the representation of different industrial subjects will be out of balance. Nor, unless it has adequate funds available, can the Museum authorities control as effectively as they should what the policy should be. As we have stressed before we feel the Museum should be striving more directly than at present to convey to less well-informed people how the application of science has influenced and is influencing their lives and to indicate to them that science is just as much a part of our modern culture as are the arts and the humanities. No doubt the authorities have their own ideas as to what their policy would be were their hands free. But when they have to work on the basis, financially, of a shoe string there are obviously difficulties in working policies out and getting them applied. In the circumstances all who visit the Museum may feel inclined less to criticise the authorities for shortcomings than to congratulate them upon the tact and firmness which they must show in imposing at least some order and unity of approach upon the arrangement of exhibits generously presented to the museum by industries and firms. Criticism, it is to be presumed, could be more effectively directed at the Treasury.

STAFF COLLEGE FOR TECHNICAL TEACHERS

At a press conference last week, Sir Alexander Fleck outlined proposals for establishing a staff college for senior teachers in colleges of technology and commerce and senior staff in industry. With the support of the Minister of Education, Sir Alexander is appealing to industry to make a " once-and-for-all " contribution of £100,000 towards the setting-up of such a college ; of that sum £60,000 has already been promised by thirty firms. The suggestion that a staff college of this kind should be provided was made originally by the committee on the supply and training of teachers for technical colleges which was appointed by the Minister of Education in September, 1956, with Sir Willis Jackson as chairman. In its report, the committee emphasised the considerable benefit to technical education resulting from residential conferences " lasting two or three weeks." These conferences, it was urged, would keep teachers in touch with new trends in science and technology, would foster a more catholic understanding in industry and elsewhere of the functions of technical colleges, and would provide opportunity for studying major problems of technical education, with a view to stimulating new methods and attitudes in the colleges.

The intention is that the staff college should be a small one offering a series of short courses of two to four weeks' duration. Probably not more than thirty would attend each course, about two-thirds of them being experienced teachers and the remainder drawn from industrial education and training officers, personnel managers, works managers, research, production and sales staff and school and university staff. Each course, it is suggested, should be devoted to a different major topic of concern to the technical colleges, dealing, for example, with the development of teaching methods, the organisation of new courses, the emergence of new technologies and college organisation and administration. Probably not more than 200 teachers or so would pass through the college in a year. Nevertheless, the objective is a useful one. It is to ensure an adequate supply of key personnel for the technical colleges, as, for example, future principals, heads of departments and other key staff. As Sir Alexander Fleck emphasised to us last week, these men must have a breadth of outlook and a familiarity with national trends in industry and commerce which will enable them to exert a powerful influence both within their colleges and upon the top managements of the firms with which they come into contact. There is no doubt that progressive improvement in the quality of this country's technical education depends a lot upon full co-operation between the colleges and industry. Realisation of that important factor, we believe, is growing. A staff college, organised in the manner outlined, cannot fail to strengthen that co-operation. The project has been carefully studied by the Ministry of Education and there has been full discussion with representatives of industry and local education authorities. The hope of all concerned is that the college may come into being before the end of next year. It is envisaged as a self-governing entity with its own governing body, consisting of representatives of industry and commerce, local education authorities and teachers. A small permanent staff, headed by a director of studies, would conduct the college under the guidance of this governing body. The annual cost of running this staff college is put at £30,000. The Minister of Education has promised a grant towards this of £10,000 and most of the balance would come from fees paid by local education authorities, Thus, the college would be maintained " mainly out of public funds." Stepping from the pulpit to the market place, we would say that it can prove a worthwhile expenditure of " public funds."

BRITISH SHIPPING

Last week in the House of Lords in a debate on the state of British shipping it was emphasised that the shipping industry could not, unaided, combat flag discrimination and the arbitrary decisions of other governments, and that in order to maintain the strength of the merchant navy consideration should be given to some form of retaliatory action. Another problem mentioned as facing the industry was that of finance and taxation, especially when the operating subsidies paid to American companies were remembered together with interest-free loans given by Germany and special tax benefits available in Greece, Italy and Japan. The scrapping of ships over twenty years old was advocated and also that owners should be allowed to allocate part of their profits to fleet replacement account. On behalf of the Government, the Parliamentary Secretary, Ministry of Transport, said that any scheme to improve the competitive position of British shipping must be carefully considered and that it was essential to know what steps were being taken to solve the problem of the world's surplus tonnage. He agreed that flag discrimination constituted a greater threat to British shipping than flags of convenience and noted that 17 per cent of the latter category of tonnage was at present laid-up compared with the 5 per cent of British tonnage. To combat the effect of the former, the Government, he reported, had made seventy-four formal protests in the last ten years to thirty-one countries, and that last year there had been some responses.

That the British shipping industry has been suffering under the strain of having to maintain its services under the triple handicap of flag discrimination, flags of con-

venience and state subsidies, has been loudly proclaimed by shipowners over the last few years. Regrettably, despite the evidence given by the serious fall in the balance of payments earned by the industry, which underlined the effect of international measures of discrimination, statements by shipowners elicited very little more than a sympathetic hearing from the Government, and the 40 per cent investment allowance : cold comfort indeed in view of the mounting difficulties and the fact that the formal protests made by the Government had largely fallen on stony ground. It must be remembered that the Americans consider that their 50 per cent carrying requirement is essential to the maintenance of their merchant fleet. However, it is to be deplored that countries newly emerging in the world of shipping have adopted the American standard in this respect rather than the British. It is obviously desirable that nations should be weaned away from such practices. But as the effort to do so does not seem at all likely to prove successful then it may well become essential to provide the British shipowner with the means to achieve economic parity with them. Management, however efficient, cannot counter the effect of artificial stimulants and freight rates at unremunerative levels can only result in the shrinking of the merchant marine. The expansion of flags of convenience fleets has meant that a very large amount of tonnage is operating tax free and so represents another economic hazard. To offset the commercial advantage of being able to accumulate financial resources for fleet replacement, the obvious countermove is to translate to British territory where such tax advantages are available, failing the equivalent tax relief at home. The proposal made for a scheme to allow owners to reserve part of the profits for fleet renewal has often been made by shipowners who have suggested that such funds should be held in escrow against the building of new tonnage. Shipowners hope that new thinking, on the part of the Treasury, will result in a better realisation of the necessity for some such action.

The desire for national fleets and other reasons have raised the world tonnage to its present level of 125 million tons which is greatly in excess of present requirements so that a large amount of tonnage, about 7,000,000 tons, is laid-up and too many ships are chasing too few cargoes. Many owners have advocated rationalisation and the introduction of a scrap and build programme ; for more than 20,000,000 tons of ships are over twenty years old while a further 32,000,000 tons are approaching this span of life. An agreement for scrapping on a two-for-one basis would reduce world tonnage by 10,000,000 tons and provide work for the shipyards ; but it would have to be on an international basis. Of the total mentioned of tonnage over twenty years old Great Britain's share is 2,800,000 tons and any scrapping programme would require financial help backed by the Government. Perhaps the time is ripe for a little of the feather - bedding, so unanimously accorded to airlines to help them to fight against international competition, to be accorded to the British shipping industry, to assist it to meet the economic threat of flag discrimination, flags of convenience and subsidies and also to maintain and even expand its fleet. If only ships had wings !

STEEL PRICES

Purchasers of all commodities always welcome a price reduction, and all sections of the engineering industry will undoubtedly welcome the reduction in iron and steel prices, details of which are given on page 274. It is the third reduction to be made in two years, with the result that the general level of British steel prices is now from 2½ to 3 per cent lower than in March, 1958. Moreover, British steel prices are substantially lower than those ruling in the U.S.A. and, for corresponding products in open hearth qualities, are generally below those ruling on the Continent. The reduction now announced is one that should give the Chancellor of the Exchequer pleasure, in view of his recent admonitions to industry to reduce prices wherever it is possible to do so. But in this price reduction there is an important factor which ought not to be overlooked. Since the middle of last year, the costs of ore, scrap, fuel, transport and labour have remained virtually unchanged and the rising demand for steel has led to the use of a higher proportion of pig iron in relation to scrap in steelmaking. As pig iron is the more expensive material, actual steel production costs have, in fact, tended to rise. Against this, however, operating experience has revealed that modern plants are proving themselves capable of greater outputs than were hitherto assumed. Consequently, the capital cost per ton of steel output is lower. This, it is estimated, has rather more than offset the higher production costs and has enabled these latest price reductions to be made. In other words, the benefits arising from the vast amount of money expended by the iron and steel industry on modernisation and development projects are being shared with the users of its products. That is good business. It is also evidence of the way in which technical progress aids the national economy.

The Engineer—100 Years Ago (FEBRUARY 10, 1860)

"THE ELECTRIC LIGHT APPLIED TO SURGERY"

"One of the greatest obstacles to the success of a surgical operation is the scanty and imperfect light, which, in some cases, is the surgeon's only guide, and is fraught with danger to the patient. Thus, the extirpation of a naso-pharyngian polypus is almost performed in absolute darkness, it being impossible to bring a common light near enough to the patient without scorching him. The problem, therefore, of finding a light which might be introduced into a cavity with impunity, remained still to be solved ; and, from a communication sent in a few days back to the Academy of Sciences by MM. Th. Dumoncel, Fonssagrives and Ruhmkorff, it would appear that this desirable object has at length been attained. Dr. Fonssagrives having long entertained the idea that electric light might be advantageously applied to the purpose, communicated his views to M. Dumoncel, a distinguished electrician, who, calling to mind the effects of electricity *in vacuo*, as exemplified in Geissler's tubes, which, although traversed by the electric light, reveal no increase of temperature, conceived the following plan for turning this circumstance to account in surgical cases of the nature alluded to. A glass tube, having a very small bore, is bent into the form of a heli or screw (the smaller the bore, the greater is the brilliancy of the light) ; by this means, a kind of luminous cylinder is formed, which is sufficiently small to be conveniently introduced even into a narrow cavity. Thus the first part of the problem was solved ; but the colour of the light was yet to be determined, since this depends on the nature of the gases introduced into the tube. As mixtures of certain gases, such as carburetted hydrogen, carbonic acid, hydrochloric acid, etc., will produce a white light, nothing remained but to fill the tube with such a mixture ; and this delicate operation was intrusted to M. Ruhmkorff, who at the same time introduced other valuable improvements into the apparatus."

Some High Spots in Thermal Power Generation

By B. WOOD, M.A.*

No. I

This paper, given before the annual meeting of the Engineering Institute of Canada, Quebec City, May, 1958, contains a topical survey of developments in large steam power plant with comments on highest points achieved in turbines and boilers at present ordered. Comments are made on trends, limitations, prospects and economic aspects. Stress is laid on the importance of choice of speed of turbines as affecting exhaust arrangement in view of the more easily won gains at the low temperature end of the cycle. A world list of outstanding units in point of size, temperature or pressure is given. Mention is also made of gas turbines.

SURVEYS of what is going on in power generation are a recurrent phenomenon. As, however, in recent years things have been developing so fast, there is always something new to say, particularly if it is permitted to range over the whole world rather than confining attention to one country. This survey is limited to thermal power station plant and ignores hydro-electric power, also the civil construction aspect. The trend with increasing power demand in countries which hitherto relied mainly on water to have to turn at least in some degree to generation from fuel is a phenomenon to be seen in the U.S.A. as well as in Canada and New Zealand, and even in Sweden and Italy.

Sizes of Power Stations and Machines

Many new stations are scheduled to contain the order of 1200MW. Some of the largest thermal power stations built to date are:

	Design rating, MW	Capability, MW
Kingston (TVA)	1440	1600
Shawnee (TVA)	1350	1500
Clifty Creek (OVEC)	1080	>1200
Kyger Creek (OVEC)	900	>1000
Fortuna, Germany	1036	—
Goldenberg, Germany	900	—
Hams Hall "A," "B" and "C," U.K.	926	—
Barking, "A" "B" and "C," U.K.	747	—
Not yet completed—High Marnham, West Thurrock and several others in U.K.	1000 to 1100	

The reason for quoting capability separately is that in the U.S.A., in contrast to Europe, plant is commonly run well above its nominal design capacity, e.g. 125–150MW sets at 165MW and 175–200MW sets at 215MW. Clifty Creek, Kyger Creek and Kingston owe their size to the power demand of nearby gaseous diffusion plants for separation of uranium isotopes. Clifty and Kyger employ 200MW cross-compound sets. Fortuna and Goldenberg are remarkable as being both brown coal plants using a very low grade fuel of 4000 B.Th.U. per pound (62 per cent water). They both use cooling towers and have existed for generations, Goldenberg having had 50MW sets in 1919, at that time the largest in the world. The stations have been recently re-equipped, Fortuna in part with 150MW sets which are at present the biggest in Europe, but a 300MW cross-compound set is on order in Italy, some 275MW single-line sets (Blyth "B") and one 550MW cross-compound for Thorpe Marsh in England. This is to date the largest in the world.

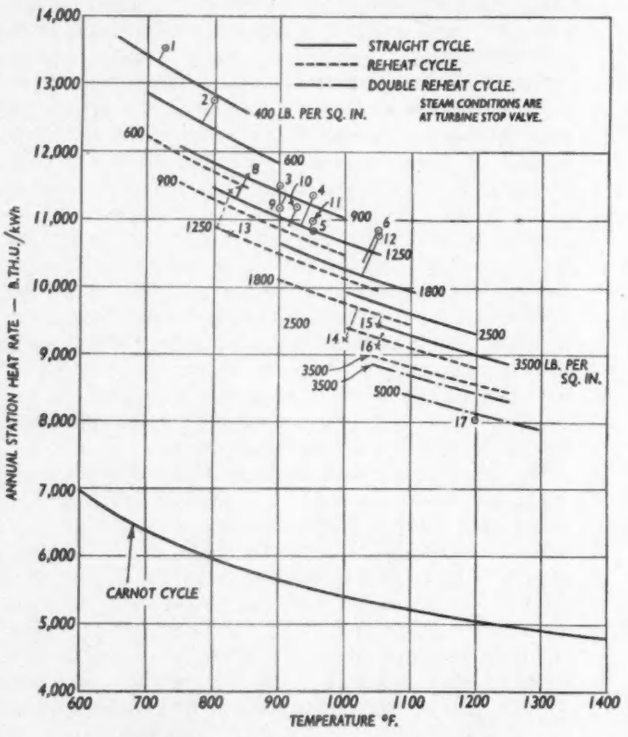
The largest set ordered in the U.S.A. is a 500MW cross-compound 3600/1800 r.p.m. unit for Widows Creek. The previous largest was 450MW for Breed, also cross-compound but 3600–3600 r.p.m. Some twenty sets of about 300MW and upwards have recently been ordered in the U.S.A. and two in Canada (see Tables I to VIII). It will be noted that in order to keep within reasonable space, in Table V (U.S.A.) the qualifying rating had to be raised to 250MW *vice* 120 for other countries.†

Cycles and Efficiencies

The best net annual station efficiency obtained to date is 37·5 per cent by Tanners Creek, with 2000 lb per square inch 1050/1050 deg. Fah., 200MW and 150MW sets. Muskingum, Kanawha River and Kyger Creek show nearly the same. All the first twenty U.S. stations use a reheat cycle of about these conditions, the first seven on cross-compound sets. The best performance shown by a British station is 31·53 per cent by Castle Donington in 1957 with 100MW sets at 1500 lb per square inch 1050 deg. Fah. non-reheat with cooling towers.

The attainment of a high efficiency calls not only for an advanced cycle, but also for good individual boiler and turbine performances obtainable only in large units and also, what is most important, with a favourable load regime. Often the latter follows automatically in an interconnected system without much hydraulic power, as all other stations descend to secondary duty in order to give the station with the lowest incremental cost as much load as possible. Even so there is commonly a substantial gap between calculated best heat rate and that attained over a year.

As regards the make-up of component efficiencies, the attainable boiler efficiency is very nearly constant for all boilers of commensurate size on hard coal, namely about 94 to 95 per cent on lower calorific value. Very little improvement can be expected on this, since the major loss, that to the stack, is unavoidable unless some radical new development takes place, such as use of corrosion resistant material in the air heater (and all that follows), thus allowing operation below the dew-point and permitting condensation to take place, so recovering some of the latent heat of the water in the stack gases. This is currently being tried at Detroit, River Rouge No. 3. However, acid dew-point corrosion and plugging has so far proved an intractable problem, since remedies found to work in one plant may fail in another under apparently similar circumstances.



1—Clarence Dock No. 1	400/725	1932
2—Fulham	600/800	1937
3—Stella South	900/900	1956
4—Stourport "B" L.P.	1250/950	1951
5—Portobello H.P.	1350/950	1955
6—Castle Donington	1500/1050	1957
7—Littlebrook "B"	1235/825/825	1950
8—Dunston "B" 2	600/850/850	1951
9—B. C. Cobb	850/900	1949
10—Tidd	1300/925	1946
11—O. H. Hutchings	1250/950	1949
12—Ridgeland 1 and 2	1800/1050	1951
13—Port Washington	1230/825/825	1938
14—St. Clair	1800/1000/1000	1954
15—Colbert	1800/1050/1050	1956
16—Kyger Creek ...	2000/1050/1050	1956
17—Eddystone No. 1	5000/1200/1050/1050 ...	1959 (expected)

Fig. 1—Station heat rates

Boiler efficiencies rarely fall much below "bogey" unless the fuel is unusual and the plans definitely go badly wrong. Low grade fuel containing much water, such as brown coal or peat, does not permit of reaching the same efficiency as on hard coal even on the lower calorific value basis. Oil permits about 2 per cent below coal on gross C.V. (2 per cent better on net C.V.).

The next component is the cycle efficiency,

* Merz and McLellan, London, England

† The above tabulation was complete at March 1, 1958. Since that time some notable additions have been made as follows. Three 500MW sets have been ordered by TVA for their Colbert station, one each from C. A. Parsons, General Electric and Brown Boveri. The Parsons set is cross-compound, similar in design to the 550MW set for Thorpe Marsh except that each line runs at 3600 r.p.m. instead of 3000. Steam conditions are 2400 lb per square inch. 1050/1000 deg. Fah. Two 200MW, 3600 r.p.m. machines have been ordered from Brown Boveri by South California Edison Company. Two 200MW sets (EEC) with corresponding boilers of 1,350,000 lb per hour (ICL) have been ordered by New South Wales Government, Australia, for Vales Point station. A 1,450,000 lb per hour brown coal-burning boiler has been ordered from KSG for Poland.

TABLE I—*GREAT BRITAIN. Outstanding Generating Sets with Associated Boiler Plant (120MW and Over or Supercritical Pressure or 1100 deg. Fah.)*

Plant	No. of sets	Manufacturer	Unit capacity, MW	Speed, r.p.m.	Steam conditions (TSV) Lb/sq. in	Steam conditions (TSV) Deg. Fah.	No. of exhausts	No. of boilers	Manufacturer	Boiler capacity, million lb/hour	Commissioning date
Margam "B"	1	RW	9	3000	3000	1050/825	—	1	SC	0·24	1959
Agecroft "B" "HP"	2	MV	120	3000	1500	1000/1000	2	2	ICL	0·86	1958/60
Belvedere "HP"	2	EE	120	3000	1500	1000/1000	3	2	John Brown	0·86	1960
Blyth "A"	4	MV	120	3000	1500	1000/1000	2	4	B and W	0·86	1958
Drakelow "B"	4	CAP	120	3000	1500	1000/1000	3	1	ICL	0·86	1958
								3	FW	0·86	1960
Kincardine	3	CAP	120	3000	1500	1000/1000	3	2	John Brown	0·86	1960
Northfleet	6	GEC	120	3000	1500	1000/1000	2	6	FW	0·86	1959
Padiham "B"	2	BTH	120	3000	1500	1000/1000	3	1	SC	0·86	1961
								1	B and W	0·86	1962
Richborough	3	RW	120	3000	1500	1000/1000	3	3	J. Thompson	0·86	1962
Rugeley	2	CAP	120	3000	1500	1000/1000	2	2	B and W	0·86	1960
	1	EE	120	3000	1500	1000/1000					
Skelton Grange "B"	4	CAP	120	3000	1500	1000/1000	2	4	Mitchell	0·86	1960
Staythorpe "B"	3	MV	120	3000	1500	1000/1000	2	3	John Brown	0·86	1958
Uskmouth "B"	3	EE	120	3000	1500	1000/1000	3	3	B and W	0·86	1958
High Marnham	5	EE	200	3000	2350	1050/1000	3	5	ICL	1·40	1959
West Thurrock	2	CAP	200	3000	2350	1050/1000	4	2	B and W	1·40	1960
Willington "B"	2	MV	200	3000	2350	1050/1000	3	1	B and W	1·40	1961
Kincardine	2	GEC	200	3000	2350	1050/1000	—	2	B and W	1·40	1963
Blyth "B"	2	EE	275	3000	2300	1050/1050	4	2	Yarrow	1·90	1962
Thorpe Marsh	1	CAP	550	3000/3000	2300	1050/1050	8	1	ICL	3·75	1963

TABLE II—*FRANCE. Outstanding Generating Sets with Associated Boiler Plant (120MW and Over or Supercritical Pressure or 1100 deg. Fah.)*

Plant	No. of sets	Manufacturer	Unit capacity, MW	Speed, r.p.m.	Steam conditions (TSV) Lb/sq. in	Steam conditions (TSV) Deg. Fah.	No. of exhausts	No. of boilers	Manufacturer	Boiler capacity, million lb/hour	Commissioning date
Violaines 1	1	CEM	115/125	3000	1510	1004/1004	2	1	Stein and Rubaix	0·77/0·86	1955
Violaines 2	1	CEM	115/125	3000	1510	1004/1004	2	1	Penhoet Fives-Lille	0·77/0·86	1958
Arrighi	1	Schneider-Creusot	117/120	3000	1270	968/968	3	1	Babcock and Wilcox	0·79/0·88	1955
Porcheville	4	CEM	125	3000	1800	1004/1004	3	4	B and W	0·79/0·88	1955
Creil St.-Leu	4	Alsthom	125	3000	1270	1004/1004	3	4	St and R	0·79/0·88	1956
Beautor 2	3	CEM	125	3000	1800	1004/1004	3	3	B and W	0·79/0·88	1957
Nantes-Chevire 3	1	Schneider-Creusot	125	3000	1270	968/968	3	1	St and R	0·79/0·88	1956
Comines 3	1	Rateau-Jeumont	125	3000	1800	1004/1004	3	1	St and R	0·79/0·88	1959
Montereau	2	Alsthom	125	3000	1800	1004/1004	3	2	St and R	0·79/0·88	1959
Les Ansereuilles	2	Rateau	125	3000	1800	1004/1004	—	2	St and R	0·79/0·88	—
Yainville	2	Schneider-Creusot	125	3000	1800	1004/1004	—	2	P.F.L.	0·79/0·88	1959
Chalon	1	Schneider-Creusot	125	3000	1800	1004/1004	—	1	B and W	0·79/0·88	—
Bordeaux-Ambes	2	Rateau	125	3000	1800	1004/1004	3	2	B and W	0·79/0·88	1959
Lacq	3	CEM	125	3000	1800	1004/1004	—	3	B and W	0·79/0·88	1960
Strasbourg	2	Alsthom	125	3000	1800	1004/1004	—	2	St and R	0·79/0·88	—
Pt. s/Sambre	1	Alsthom*	125	3000	1800	1004/1004	—	1	St and R	0·79/0·88	1960
Emile Huchet	2	CEM	125	3000	1800	1004/1004	—	2	B and W	0·88	—
								1	Walther	0·88	—
Richemont	2	CEM	125	3000	1800	1004/1004	—	1	P.F.L.	0·88	—
Hornaing	2	CEM	125	3000	1800	1004/1004	—	2	P.F.L.	0·88	1958
Champagne sur Oise	1	Schneider-Creusot	250	3000	2000	1050/1050	4	1	B and W	1·55/1·7	1961
Site not determined	1	Rateau	250	3000	2350	1050/1050	4	1	St and R	1·55/1·7	1961

* Not yet ordered.

TABLE III—*GERMANY. Outstanding Generating Sets with Associated Boiler Plant (120MW and Over or Supercritical Pressure or 1100 deg. Fah.)*

Country	Plant	No. of sets	Manufacturer	Unit capacity, MW	Speed, r.p.m.	Steam conditions (TSV) Lb./sq. in	Steam conditions (TSV) Deg. Fah.	No. of exhausts	No. of boilers	Manufacturer	Boiler capacity, million lb/hour	Commissioning date
GERMANY	Huels	1	SSW	16·5	3000	4300	1112/	—	1	Dürr	0·55	1956
		1	BBC	71	3000	1500	1050/1050	3				
	Neuhof	1	SSW	80	3000	2550	1112/968	2	1	Dürr	0·5	1957
	Hattingen	2	AEG	100	3000	3200	1112/987	2	2	Dürr	0·685	1958/9
	Viktor Ickern	1	SSW	125	3000	2560	995/995	2	1	D. B and W	0·88	1960
	Mannheim	1	BBC	125	3000/3000/3000	2000	968/905/905	6	1	D. B and W	0·44	1954
									1	KSG	0·44	
	Weisweiler	1	BBC	150	3000	1500	977	3	1	Dürr	0·66	1955
									1	Sulzer	0·66	
		1	MAN	150	3000	2580	977/977	2	1	Walther	0·99	
	Fortuna 3	1	AEG	150	3000	2580	977/977	2	1	Steinmüller	0·99	1957
		1	SSW	150	3000	2580	977/977	2	1	Walther	0·99	1956
	Frimmersdorf 2	5	BBC	150	3000	2430	995/995	3	1	Dürr	1·0	1957
									1	VKW	1·0	
	Frimmersdorf 2	2	SSW	150	3000	2430	995/995	3	1	VKW	1·05	—
									1	Bückau	1·05	
	Walsum Mine	1	MAN	150	3000	2580	977/977	2	1	D. B and W	1·05	1959
	Westerholt	1	SSW	150	3000	2560	995/995	2	2	VKW, Steinmüller	—	1959
	Arenberg	1	SSW	150	3000	2560	995/995	2	2	KSG	—	1960
	Prinz Regent Nord	2	AEG	150	3000	2580	977/977	2	—	—	—	—
	Stade	1	SSW	125	3000	2560	995/995	3	1	D. B and W	0·88	1960
SAAR	St. Barbara	1	MAN	150	3000	2800	977/977	2	1	MAN	1·0	1959

TABLE IV—*REST OF EUROPE. Outstanding Generating Sets with Associated Boiler Plant (120MW and Over or Supercritical Pressure or 1100 deg. Fah.)*

Country	Plant	No. of sets	Manufacturer	Unit capacity, MW	Speed, r.p.m.	Steam conditions (TSV) Lb/sq. in	Steam conditions (TSV) Deg. Fah.	No. of exhausts	No. of boilers	Manufacturer	Boiler capacity, million lb/hour	Commissioning date
BELGIUM	Baudour	1	EW	115	3000	2350	1102/1048	3	1	Sulzer	0·75	1959
HOLLAND	Amer	1	BBC	120	3000	1465	1004/1004	3	1	Scheldt	0·79	1957
	Harculo	1	BBC	131	3000	2350	995/995	3	1	Stork	0·93	1960
	Buggenum Plem	1	SSW	125	3000	2400	1004/1004	2	1	Breda-Sulzer	0·93	1959
	Velsen	2	Stork	125	3000	1800	986/986	—	2	Scheldt-Breda-KSG	0·93	1959/60
	Amer 3	1	BBC	175	3000	2430	1050/1004	3	1	Scheldt-Sulzer	1·12	1959
SWEDEN	Stenungsund	4	STAL	150	3000/1500	1590	968/932	2	4	Svenska Maskinverken	1·02	1959
DENMARK	Asnaes	2	BBC	120	3000	1800	1000/1000	3	1	Elsinore	—	1957/59
									1	Burmeister		
ITALY	Sta. Barbara	2	BBC	125	3000	1500	1000/1000	3	2	D. B and W	0·77	1958
	Chivasso 2	1	Ansaldo	140	3000	1800	1000/1000	2	1	Ansaldo	0·99	1956
	Civita Vecchia	1	Ansaldo	140	3000	1800	1000/1000	2	1	Ansaldo	0·93	1956
	Tavazzano 2	1	SSW	140	3000	2400	1000/1000	3	1	Sulzer	0·94	1957
	Genoa	1	Tosi	150	3000	2000	1000/1000	2	1	Tosi	1·05	1957
	Vigliena (Naples)	1	Ansaldo	150	3000	2400	1000/1000	2	1	Ansaldo	1·1	1957
	Not fixed	1	Tosi	300	3000/3000	2400	1050/1000	4	1	CE-Tosi	2·2	1958
POLAND	Katowice	2	MV	120	3000	1800	1000/1000	3	—	—	—	1961
RUSSIA	Cherepet 1 and 2	2	Leningrad-Electrosila	150	3000	2400	1050/977	2	5	Taganrog	0·53	1956
	Cherepet 3 and 4	2	Leningrad-Electrosila	150	3000	2400	1050/977	2	3	Taganrog	0·53	1958
	S. Urals 9 and 10	2	Leningrad-Electrosila	200	3000	2400	1040/986	—	—	—	—	1958
SPAIN	Escombreras	1	GE	125	3000	1800	1000/1000	2	—	—	—	1957
FINLAND	Naantali	1	AEG	125	—	2400	986/1004	—	1	Sulzer	0·93	1960

which is the main variable under the designer's control. Cycle efficiency in this paper means the thermal efficiency of a turbine of invariant standard stage efficiency. This is a useful concept though arbitrary. We have no other practical criterion, since neither Rankine nor Carnot efficiency gives a figure close enough to reality to be of use as a yardstick. Fig. 1 shows the trend of station heat rate against initial steam temperature as main variable. It is not practicable to show in a single diagram the effect of all variables. Size of machine, date of manufacture, pressure, reheat temperature and exhaust conditions, are all significant influences of about the same order. Potential gains by better cycles have now reached the point where between one accepted cycle and the next most advanced the step is so small—say 4 per cent (multiplicatively), that the difference between a good turbine and a poor one will span it. Hence we do not always find station efficiencies attained in the order of their prospective cycle efficiencies. The cycle efficiency is determined by blade efficiency, average steam temperature, pressure, vacuum and precise arrangement of feed heaters and other details. Average steam temperature is mentioned to take account of reheat, not just initial steam temperature. The Carnot heat rate is also shown in Fig. 1 as a matter of interest though, for comparison, the turbine heat rate should really be used. Turbine heat rates of the order of 7200 are now in sight implying 50 per cent efficiency. Thus a milestone is about to be reached where only half the throttle heat will be rejected to the exhaust.

Over a wide range of cycles the following figures are broadly correct:

	Gain, per cent
For each 100 deg. Fah. in steam temperature (and reheat simultaneously)	3–3½
For first reheat to full temperature of plain cycle	4–4½
For second reheat	1–1½
For each doubling of pressure subject to deduction for feed pump	7
For each 6 deg. Fah. lower vacuum temperature (at constant leaving loss)	1

The capital costs incurred in attaining these gains are not uniform, though a true economic design ought in principle to show the same incremental return for a small change of each separate variable, subject to adjustment for cost of maintenance and risk of outage or breakdown and any other relevant factor.

Maximum pressure should be a matter settled by economics, i.e. how much it is worth to pay, though prestige sometimes

TABLE V—*UNITED STATES OF AMERICA. Outstanding Generating Sets with Associated Boiler Plant (250MW and Over or Supercritical Pressure or 1100 deg. Fah.*

Plant	No. of sets	Manufacturer	Unit capacity, MW	Speed, r.p.m.	Steam conditions (TSV) Lb/sq. in	Steam conditions (TSV) Deg. Fah.	No. of exhausts	No. of boilers	Manufacturer	Boiler capacity, million lb/hour	Commissioning date
Philo No. 6	1	GE	125	3600	4500	1150/1050/1000	2	1	B and W	0·675	1957
Kearny "B," Nos. 1 and 2	2	GE	145	3600	2350	1100/1050	3	2	CE	0·995	1953
Burlington No. 7	1	WE	185	3600	2350	1100/1050	3	1	B and W	1·225	1955
Avon No. 8	1	WE	215	3600	3500	1100/1050	3	1	CE	1·715	1959
Linden No. 2	1	GE	225	3600	2350	1100/1050	3	1	B and W	1·9	1958
Gallatin Nos. 1 and 2	2	WE	250	3600	2000	1050/1050	3	2	CE	1·65	1956 and 1957
Dan E. Karn No. 1	1	WE	250	3600/3600	2450	1050/1050	4	1	CE	1·75	1959
Dan E. Karn No. 2	1	WE	250	3600/3600	2450	1050/1000	4	1	B and W	1·75	1960
Memphis Nos. 1, 2 and 3	3	WE	250	3600	2400	1050/1050	3	3	B and W	2·0	1958 and 1959
Meramec No. 3	1	GE	250	3600/1800	2000	1000/1000	1	1	FW	1·85	1958
Oak Creek No. 5	1	AC	250	3600/1800	2400	1050/1000	2	1	FW	1·78	1959
Indian Point No. 1	1	WE	250	1800	355	1000	2	2SH	FW	1·075	1960
River Rouge No. 1	1	GE	260	3600/1800	2000	1050/1000	2	1	B and W	1·72	1956
River Rouge No. 2	1	WE	260	3600/1800	2000	1050/1000	2	1	CE	1·71	1957
Smithers Lake No. 3	1	WE	275	3600	2000	1000/1000	3	1	FW	1·95	1961
Gallatin Nos. 3 and 4	2	WE	275	3600	2000	1050/1050	3	2	CE	1·96	1958
Will County No. 3	1	GE	275	3600/1800	2000	1050/1050	2	1	CE	1·69	1957
Allen Nos. 3 and 4	2	GE	275	3600/1800	2400	1050/1000	2	2	CE	1·8	1959 and 1960
Bergen Nos. 1 and 2	2	WE	290	3600/3600	2350	1100/1050	4	2	FW	1·9	1958 and 1959
Brunner Island No. 1	1	WE	300	3600/3600	2400	1000/1000	4	1	CE	2·1	1960
Fisk No. 19	1	AC	300	3600/1800	2000	1050/1000	2	1	CE	2·2	1958
Mercer No. 1	1	GE	300	3600/3600	2400	1100/1050	6	—	—	—	1960
Meramec No. 4	1	WE	300	3600/1800	2000	1000/1000	1	1	FW	2·31	1961
Pittsburgh No. 5	1	WE	300	3600/3600	2400	1050/1000	4	1	B and W	2·16	1960
Pittsburgh No. 6	1	GE	300	3600/3600	2400	1050/1000	4	1	B and W	2·16	1961
River Rouge No. 3	1	AC	300	3600/1800	2400	1050/1000	2	1	FW	2·0	1958
Crawford Avenue No. 8	1	WE	305	3600/1800	2400	1050/1000	2	—	—	—	1961
Eddystone No. 1	1	WE	325	3600/1800	5000	1200/1050/1050	2	1	CE	2·0	1959
Eddystone No. 2	1	GE	325	3600/3600	3500	1050/1050/1050	6	1	CE	2·178	1960
Joliet No. 6	1	GE	325	3600/1800	2000	1050/1000	2	1	B and W	2·2	1959
Middle South Utilities Co.	1	WE	325	3600	2000	1000/1000	4	—	—	—	1960
St. Clair No. 5	1	GE	325	3600/1800	2400	1050/1000	2	1	B and W	2·1	1959
St. Clair No. 6	1	WE	325	3600/1800	2400	1050/1000	2	1	CE	2·1	1960
Waukegan No. 7	1	GE	325	3600/1800	2000	1050/1000	2	1	CE	2·05	1958
Astoria No. 3	1	GE	335	3600/1800	2000	1050/1000	2	1	B and W	2·4	1958
Arthur Kill No. 2	1	GE	335	3600/1800	2000	1050/1000	2	1	B and W	2·4	1959
Astoria No. 4	1	AC	340	3600/1800	2000	1050/1000	2	1	CE	2·5	1961
Breed No. 1	1	GE	450	3600/3600	3500	1050/1050/1050	6	1	B and W	2·923	1959
Philip Sporn No. 5	1	GE	450	3600/3600	3500	1050/1050/1050	6	1	B and W	2·923	1959
Widows Creek No. 7	1	GE	500	3600/1800	2400	1050/1000	2	1	CE	3·85	1960

N.B.—There are some twenty-four sets in service in the U.S.A. of nominal 201MW–249MW rating and probably 163 sets in the range 120MW–200MW.
There are some twenty-two sets on order in the U.S.A. of nominal 201MW–249MW rating and probably 118 sets in the range 120MW–200MW.

TABLE VI—*CANADA. Outstanding Generating Sets with Associated Boiler Plant (120MW and Over or Supercritical Pressure or 1100 deg. Fah.)*

Plant	No. of sets	Manufacturer	Unit capacity, MW	Speed, r.p.m.	Steam conditions (TSV) Lb/sq. in	Steam conditions (TSV) Deg. Fah.	No. of exhausts	No. of boilers	Manufacturer	Boiler capacity, million lb/hour	Commissioning date
Ioco	6	MV	150	3600	1800	1000/1000	3	6	CE	1·25	1961
Wabamun	2	MV	150	3600	1800	1000/1000	3	—	—	—	First in 1961
Richard L. Hearn	4	CAP	200	3600/1800	1800	1000/1000	2	2	B and W	1·35	1958–1960
								2	CE	1·35	
Lake View, Nos. 1 and 2	2	CAP	300	3600/1800	2350	1000/1000	4	2	B and W	2·00	1961

TABLE VII—*JAPAN. Outstanding Generating Sets with Associated Boiler Plant (120MW and Over or Supercritical Pressure or 1100 deg. Fah.)*

Plant	No. of sets	Manufacturer	Unit capacity, MW	Speed, r.p.m.	Steam conditions (TSV) Lb/sq. in	Steam conditions (TSV) Deg. Fah.	No. of exhausts	No. of boilers	Manufacturer	Boiler capacity, million lb/hour	Commissioning date
Chiba 1	1	GE	125	3000	1800	1000/1000	2	1	CE	0·96	1957
Chiba 2	1	Toshiba	125	3000	1800	1000/1000	2	1	Mitsubishi	0·96	1957
Shintokyo 6	1	Toshiba	125	3000	1800	1000/1000	2	1	Mitsubishi	0·96	1957
Shin Nagoya	1	GE	156	3600	2400	1050/1000	3	1	CE	1·15	1958
Osaka	2	Westinghouse	156	3600	2400	1050/1000	3	2	CE	1·15	1958
Osaka	1	Westinghouse	156	3600	2400	1050/1000	3	1	Mitsubishi	1·15	1958
Osaka	1	Mitsubishi	156	3600	2400	1050/1000	3	1	Mitsubishi	1·15	1958
Karita	1	Westinghouse	156	3600	2400	1050/1000	3	1	CE	1·15	1958
Karita 3	1	Westinghouse	156	3600	2400	1050/1000	3	1	Mitsubishi	1·15	—
Chiba 3	1	GE	175	3000	2400	1050/1000	3	1	Babcock	1·30	1958
Chiba 4	1	GE	175	3000	2400	1050/1000	3	1	Babcock-Hitachi	1·30	1959
Sendai	1	GE	175	3000	2400	1050/1000	3	1	Babcock-Hitachi	1·30	1959
Shin Nagoya	1	GE	220	3600	2400	1050/1000	3	1	Mitsubishi	1·60	1959
Yokosuka	1	GE	265	3000/3000	2400	1050/1050	4	1	Mitsubishi	2·00	1960

TABLE VIII—*SOUTHERN HEMISPHERE. Outstanding Generating Sets with Associated Boiler Plant (120MW and Over or Supercritical Pressure or 1100 deg. Fah.)*

Country	Plant	No. of sets	Manufacturer	Unit capacity, MW	Speed, r.p.m.	Steam conditions (TSV) Lb/sq. in	Steam conditions (TSV) Deg. Fah.	No. of exhausts	No. of boilers	Manufacturer	Boiler capacity, million lb/hour	Commissioning date
AUSTRALIA	Yallourn "E"	2	MV	120	3000	1500	1050	2	2	B and W	0·95	1961
BRAZIL	Piratininga	2	GE	125	3600	1800	1000/1000	2	—	—	—	1960
ARGENTINE	Buenos Ayres	5	BTH	120	3000	1750	1040/1000	2	5	ICL	0·79	1961

enters into the argument. Size of unit and expected operating regime, i.e. base load or daily starting, also affect the choice. The notional gain with increase of pressure, which amounts to about 1 per cent per 10 per cent pressure increment, is constant, but at about 2000 lb per square inch begins to be seriously cut into by the boiler feed pump power. Thus doubling 2000 lb pressure leads to the usual notional gain of about 7 per cent offset by 2 per cent, but the next doubling from 4000 to 8000 will be offset by about 4 per cent and so at present is not worth while, even though about one-third of the feed pump power is recovered in the turbine. The maximum temperature, on the other hand, tends to be settled at a given time by what is thought to be practicable or on the verge of becoming practicable particularly in the pipework, superheater headers and valves. Thus choice of temperature is not in the main a matter of price, but of how far we dare risk going with materials obtainable and existing welding techniques. Each new advance in temperature is in some degree a matter of faith or "chancing the arm" to the point where operating reliability might be jeopardised. Guesses have not always turned out right and, where too bold a choice has been made, a certain amount of replacement of pipe and even parts of turbines has sometimes had to be done within a few years. Asking for too high an operating temperature may also greatly delay delivery, as the forgemaster has difficulty in drawing pipe which retains high strength at temperatures approaching forging temperature. Similarly, it may drive the turbine manufacturer into the use of austenitic steels which, because of their high coefficient of expansion, combined with low conductivity, calls for greater clearances. The net effect is that the prospective gains by higher temperature are partly lost in additional leakages. Hence a rather large step in temperature has to be made to justify austenitics. Part of the superheater is almost invariably already in austenitic material because of both strength and scaling considerations, but preferably not the headers. However, it is because temperature pays good dividends and better alloy steels have successively become available that temperatures have risen rapidly from 825 deg. and 900 deg. Fah. before the war in the best station in the world (950 deg. Fah. highest in use) to 1050 deg. Fah. now, with 1100 or even 1150 just coming into use in public supply; 1200 deg. Fah. has, however, been used for some years at Leverkusen in Germany in an industrial plant. Pressure, on the other hand, already 1200 lb per square inch in the best station and 2500 elsewhere before the war, has not advanced much until the recent supercritical plants were ordered; 2300 lb per square inch is still a high pressure, the highest, 4500, is in use at Philo and 5000 is to be used at Eddystone, but these pressures are not claimed to be economic nor thought to be appropriate to units of less than 300MW.

Clearly to go to above critical pressure of 3200 lb per square inch calls for a radical change in boiler design. Higher pressure always affects all of the pressure parts and any advance on 2400 lb would appear to be unduly costly, though this trend can be offset by the use of small tubes and absence of drums and adoption of a large unit. There are no immutable laws of economics and desire on the part of a boilermaker to get a high pressure reference plant can alter the price position at any time. Raising of temperature, on the other hand, affects only a part of the superheater and reheater (if any), the pipework and the nozzle boxes of the turbine and, though it may enforce limited use of materials which are very costly per pound, the total effect in the plant price is not up to a point so serious. Since, however, we cannot at the moment face temperatures higher than about 1050 for routine work, reheat and even double reheat come into their own by allowing fuller use of a limited top temperature. The present position is that on medium price fuel, e.g. 30d per million B.Th.U., no pressure above 2400 lb and no temperature above 1050 deg. Fah. can ordinarily be economically justified.

Minor factors affect the cycle efficiency in small degree. They involve compromise between the most economic positioning of feed heaters and reheaters, the location in the cycle and method of driving the boiler feed pump and similar matters, such as cascading the feed heater drains or pumping them forward. In general, there are no surprises; choices are not critical, since most of the curves have fairly flat tops. All variables are inter-related and basic thermodynamic theory gives doubtful help. There may be no reliable way of finding the best combination other than working out a large number of variations. If this is entrusted to computers, it is necessary to feed into them all the relevant data: this is difficult because essential truths sometimes dawn on one only during application to routine calculations.

The difficulty and cost of winning more gains at the top has drawn attention to the less spectacular but more easily won improvements at the exhaust end of the turbine in much the same way as mentioned above and later in connection with boilers. It was at one time conventional in the U.S.A. to work with a very tight exhaust, resulting in a cheap turbine, but implying high velocity of exhaust steam. This high velocity represents loss of energy—the leaving loss. Before the war this was often as much as 4 per cent. In recent designs it is cut to as low as ½ per cent. The percentage leaving loss tends to fall with higher cycle conditions in any case. Leaving loss is strictly a matter of turbine design, not of cycle efficiency since, in discussing cycles, we charge them all with the same token leaving loss. It is, however, a customer choice. The leaving loss ordinarily becomes serious only when the vacuum is good. Hence for Canadian conditions with cold circulating water a very large exhaust is necessary in order to be able to utilise properly the good vacuum attainable and may be a good investment. In evaluating the gain by a larger exhaust area or better vacuum, it is important to realise that the fuel saving is not the only component. There is also a value of the order of 150 dollars per kilowatt to be put on each extra kilowatt obtained. On a moderate load factor this component may well be equal to the value of the fuel saving. Hence the gain is double what is commonly thought. It seems probable that decisions in favour of tight exhausts must often have been reached by incorrectly ignoring the extra kilowatts which, it should be appreciated, are obtained without affecting fuel consumption or any other part of the plant, boiler, coal handling (except beneficially cooling water requirements). Moreover in assessing the capital value of annual fuel savings over the life of the plant, it is necessary to select a capitalising factor. This is the reciprocal of the annual charges attributable to capital expenditure. Very different figures are often quoted for "financial charges," e.g. 7½ per cent in U.K. and 15 per cent in U.S.A. These differences, however, reflect the different business philosophies or nomenclature in the countries concerned rather than real differences in money rates. For publicly owned undertakings financed by fixed interest loans it appears that for the purposes of economic choice the annual charges need to cover only interest and sinking fund, management and some allocation in the nature of insurance. Together these amount to a round figure of 9 to 10 per cent over a wide range of money rates. Hence a capitalising factor of 10 or 11 is appropriate when the gains have already been realistically computed, and any difference in maintenance or operating costs already taken into account.

(To be continued)

Construction and Behaviour Characteristics of Tyres

Mr. T. French, of the Tyre Design Division of the Dunlop Rubber Company, Ltd., presented to the Automobile Division of the Institution of Mechanical Engineers on Tuesday, February 9, the paper which is abstracted here.

IT is logical and indeed now absolutely necessary for the tyre designer to put clearly before the automobile engineer the variations in tyre performance properties which are currently available, the trends which could be accentuated if called for, together with an indication of the initial and running cost factors involved.

ROAD ADHESION AND GENERAL STABILITY

In the field of road adhesion and general stability tyre construction and vehicle design variables can have a very marked effect: the difference between a good and less good tyre/car combination is still considerable, although the gap is tending to diminish as the primary arts in this sphere become generally known and adopted. To go back only a very few years the best and worst car (including tyre variables), in terms of maximum speed round a particular bend on a wet road surface, taken from an extensive selection of the world's automobiles, showed the following results:

Worst: 29 m.p.h.—vicious rear breakaway.

Best: 46 m.p.h.—progressive front breakaway.

This represents an increase in effective sideways grip of 2½/1.

It has been found that to make steady progress in this respect, testing techniques capable of assessing discretely and quantitatively variables of the above nature have had to be developed. A project involving comparison of two types of tyre (perhaps a new design compared with an old design), or a particular tyre-vehicle stability feature which called for investigation would be tackled substantially on the following lines:

(1) *Basic Data Cornering Force Machine.*—Data covering side force/slip angle/self-aligning torque for appropriate loads and inflation pressure are obtained from the

cornering force machine. Camber variables are included if relevant. The drum surfaces used are chosen specifically to line up with the project in hand, as the order of merit of tyre construction and tread patterns and materials can change from one surface to another. This applies both to dry surfaces (mainly important for racing and high-speed work) and wet conditions where a variety of surfaces with μ down to 0·15 can be applied.

(2) *Proving-Track Work.*—The translation of data from proving-track work into directly useful road data, in both a qualitative and quantitative sense, has led to the development of a number of related proving-track techniques. All those involving lateral forces are based on a steady-speed cornering system. A suitable corner, usually marked out with rubber markers on the Fort Dunlop Proving Ground, is taken at successively increasing approach speeds, up to the point when vehicle breakaway is complete. A pattern of behaviour is built up, which it has been found can be accurately repeated by trained drivers, and which lines up well with the basic data from the cornering force machine. Either "whole car" behaviour can be studied, that is, a complete tyre change on one car, or comparison of one car with another, or of more value in pure tyre development, breakaway can be limited to one end of a test vehicle by anchoring the other end with special tyres, used solely for the purpose.

There are a number of variations on this technique which have been found of value; the effect of applying torque in a bend on a wet surface can be appraised by fitting a throttle limitation stop, again using the approach speed as the variable factor. This is a particularly important feature with high-powered cars on wet roads, and both tyre and vehicle design have a marked influence on the results obtained. In particular, if full adhesion is to be maintained, wheel spin on the inner (lightly laden) wheel must be prevented. A straight-ahead test has been devised to measure the ability of tyres to resist wheel spin. Locked wheel braking is measured with a recording accelerometer. Although, in general, little instrumentation has yet been attempted to measure transient and feel effects some of the more important ones are readily assessable by this sort of technique, such as rate of breakaway, loss of feel, &c.

It would not be fair to pass on to a review of specific tyre features without saying that, in the last resort, it is the normal road-driving behaviour which counts. This is always checked, and so far has invariably lined up with the picture obtained from the proving track, which is midway between the laboratory and road operation and the cornering force machine, solely in the laboratory.

Having established, in outline, a comprehensive background against which tyre constructional variables can be usefully and realistically assessed and appraised on vehicles, some of these variables can be considered in detail in terms of the way performance is affected.

Dry-Road Cornering Power

Cornering power on a dry road is not a primary problem on the public highway, but it is very significant from the racing standpoint, where the small differences that exist in limiting cornering power and in control can gain or lose that vital one or two seconds per lap.

A cornering force plot of typical tyres is given in Fig. 1, from the aspect of the tyre for normal road operation.

General lateral stiffness of the tyre, particularly under the tread region, is the most significant parameter. Very high cornering power in the low side force region gives, as would be expected, a "running on rails" feeling to a car, which is generally liked.

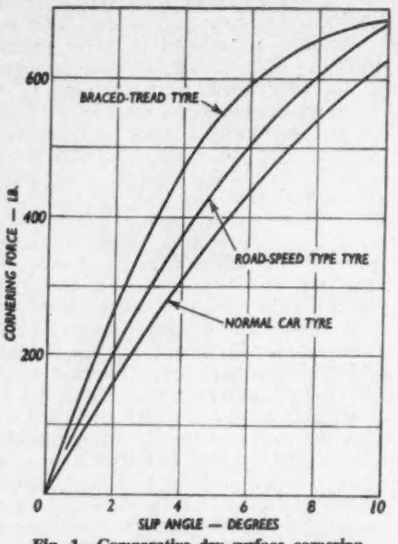


Fig. 1—Comparative dry surface cornering properties, car type tyres

It is usually associated with less progressive behaviour as the limit of adhesion is approached, but this is not of much significance on the road. Of more practical interest is the fact that over the usable range of inflation pressure, cornering power for each of these tyre types does not change much as pressure is reduced: this is due to a partial compensating effect provided by the increased size of contact area at the lower inflation pressure. Also, the softer tyre with bigger enveloping power, corners more effectively on roughish or knobbly surfaces, owing to better continuity of ground contact.

The limiting factors on lowering the pressure too far are reduction in tyre endurance and tread life, increasing self-aligning torque, worse tyre squeal, and lowering of the yaw frequency of the mass of the car in relation to the points of tyre contact with the road. Reduction of lateral tyre-casing stiffness is very marked with banded tyres; the yaw frequency for a medium-size car changes from 200 c/minute with conventional tyres, to 145 c/minute with banded tyres. A low yaw frequency gives an increased tendency for a time-lag effect to arise, which is particularly noticeable at speed: full steering response from the tyres is not attained until the mass of the car reaches its equilibrium position in relation to the tyre-road contact areas, following a steering wheel input and change of heading.

Self-Aligning Torque

With new standards set by power-assisted steering on large cars, all saloon models, except the smallest, now have a potential heavy steering problem. It happens with the heavy front-wheel loads currently in vogue coupled with the tyre equipment in use, that the steering wheel torques required both for parking and for steering the car round traffic islands and sharp bends, are reaching the "upper comfort" level of the human arm-shoulder system. Sensitivity, particularly of lady drivers, is great at the levels now obtained, and only a small change in steering torque appears disproportionately large. Data such as that below has appeared before: these particular figures were obtained at Fort Dunlop from tests involving a wide selection of drivers:

	Maximum desired force at steering wheel rim	
	Mean, lb	Range, lb
Slow-speed manœuvre	13·3	8·4–18·0
Holding on bend	10·7	6·0–15·6

The limitation of self-aligning torque presents a virtually insoluble dilemma to the tyre engineer. By the sheer dimensions of the contact area and the high rubber/road coefficient of friction (μ) obtained, only relatively small alterations can be made; the parameter which has most effect is that of the general modulus of the tyre casing. A stiff casing has a lower self-aligning torque than a more flexible one, but directly at the expense of comfort. This partial relationship between self-aligning torque and casing modulus is the main reason why used tyres are heavier to steer than new ones. As a tyre is flexed, the casing becomes more supple, and the self-aligning torque increases. With normal road usage, the increase in self-aligning torque is about 30 per cent from new after 1000 miles and then only increases a few per cent to the end of the tread pattern life. There is really nothing the tyre engineer can do, and the sensible thing is to regard the running self-aligning torque as the norm and the new tyre value as being a transitory effect. This is analogous to running in a stiff engine.

Wet-Road Adhesion

It is in the area of wet-road adhesion that the greatest need for improvement has existed; fortunately significant gains have been made in the past few years, and there are possibilities of a further increase both in the quantitative and qualitative aspects of tyre adhesion.

The need for better wet-road grip and behaviour is exemplified by the D.S.I.R. figures, published in 1956, of "Personal Injury" accidents involving skidding, in 1954.

Condition of road surface	Number of accidents
Dry	8,180
Wet	13,390
Snow or ice	3,930

It is reasonable to assume that the general incidence of skids and skidding accidents is in line with these proportions and thus in terms of sheer numbers the problem of the wet road in Great Britain is most urgently in need of close attention from vehicle, tyre, and road engineers alike.

First, let the tyre features which have already assisted towards obtaining a better grip be examined.

Tread Pattern and Tread Shape.—The form of relationship between effective friction and percentage slip of rubber on a wet surface, shown in Fig. 2, is now well known.[1]

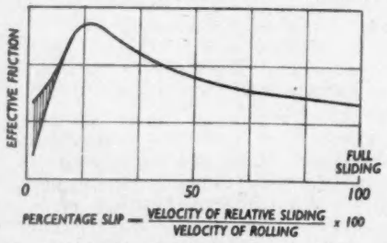
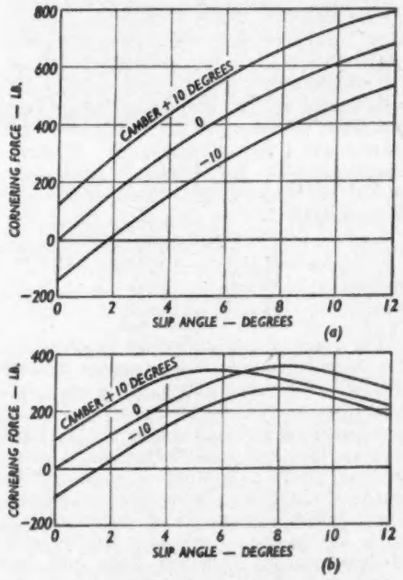


Fig. 2—Friction curve

Thus peak grip involves what is virtually static or low percentage slip friction. One way to increase this figure for a particular block (tread-pattern element) of rubber is to increase the number of pressure edges in it, where by marginal distortion such edges push effectively right through the water film to the dry surface beneath. Such edges are

naturally most effective when disposed at right angles to the applied force. It is for this reason that modern automobile tyre-tread patterns carry a multiplicity of knife cuts in the ribs, which themselves preferably have serrated edges to increase the length of pressure-edge contact. From the standpoint of sheer grip, the upper limit of the number of knife cuts per unit area of tread has not yet been reached, but there are clearly limitations concerned with the general pattern stiffness for optimum tread wear, tearing, and dry road stability. It is important to note that not only must such pressure edges exist, but also sufficient drainage channels (essentially circumferential grooves), through which the water expelled by the pressure of the rubber on the ground, can flow out of the way.

The main effect of the shape of the tread profile is on the efficiency of the contact area as a whole to prevent local slipping. As a corollary to this point, it should be mentioned that camber also affects the overall efficiency of the contact area to provide maximum grip without undue local slipping. Fig. 3 shows the measured effect of positive and negative camber on dry and wet surfaces : it is both interesting, and from the vehicle design standpoint, important to note that on



(*a*) Dry surface. (*b*) Slippery wet surface.

Fig. 3—Comparison of camber effect on dry and wet surfaces

slippery wet surfaces, optimum behaviour is obtained at or near to zero camber.

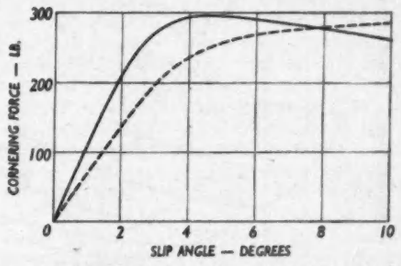
Tread Rubber Compound.—It was postulated for many years that "rubber was rubber" and that its adherence to any other surface was more or less constant for a particular set of conditions. But with basic changes in the rubber polymers which the synthetic rubber industry has made available, allied with experimentation in compounding techniques, a new situation has been unveiled.

Tabor,[2] Giles and Sabey,[3] have explained how the high hysteresis losses of such rubbers can improve friction for sliding conditions, and whilst it is doubtful whether this is the total explanation of the improved grip which such materials give over a wide range of wet-road operating conditions, it is a fact that the advantages and disadvantages of their use is under active review.

The effects of tread pattern design and of tread material have proved substantially additive, and overall have led to an increase of 30 to 40 per cent in peak sideways adhesion on wet, slippery surfaces in the past few years.

Tyre Construction.—The main variable which has emerged concerns the choices of wet-road behaviour offered by the normal cross-bias tyre construction on the one hand, and by the family of braced-tread-flexible-casing group of tyres, on the other. Actual wet-surface cornering force plots, up to and beyond the limit of adhesion, together with proving track values, appear in Fig. 4.

The data shown give almost the whole



——— Braced-tread tyre, 33 m.p.h., limiting adhesion (breakaway not predictable)
– – – Conventional tyre, 32 m.p.h., limiting adhesion (warning of breakaway with improved control).

Fig. 4—Wet adhesion of rigid breaker and conventional tyres on drum and proving track

story : the braced-tread tyre still exhibits, in the wet, the "running on rails" behaviour associated with low attitude angles, which is a good feature. The limiting behaviour, however, is less attractive : the transition from total grip to complete sliding is sudden, without obvious warning to the driver : with the cross-bias tyre, the progressive increase in attitude angle serves, at around 5 deg. to 7 deg. as an indication that total sliding is imminent, if speed is increased, or the radius of turning reduced. It is possible, with the braced-tread construction, by reducing the lateral bending stiffness of the breaker materials, to produce a tyre with high wet adhesion and with characteristics part way towards those of the conventional tyre. Unfortunately, this gain in qualitative aspects of road adhesion is offset by a loss in tread life compared with the full braced-tread tyre, while the undesired high-frequency ride characteristics of the latter are to a large degree retained.

TYRE ENDURANCE AND TREAD PATTERN LIFE

Tyre failure due to fatigue of the materials used in its construction is now an infrequent event. This is in spite of a gradually increasing severity in operating conditions (faster cars, "faster" roads, &c.), and is a result both of extensions of knowledge in tyre technology, and to the wide use of newer and stronger materials. It is not commonly realised that over the past few years automobile tyre materials have changed largely from basically natural vegetable derivatives (cotton, natural rubber) to wholly synthetic products (viscose yarn, nylon, synthetic rubber). A full discussion of this aspect of tyre performance would be more appropriate solely between tyre engineers, but there is one aspect, and indeed plea, which can be reasonably restated to the automobile engineer proper. This concerns the relatively small margins in hand for automobile tyres against an insupportable level of tyre structural failure, and concomitant customer dissatisfaction. This situation is intrinsic in the basic materials, the dimensions and desired performance parameters and the cost of the tyres. Only a relatively small increase in general severity of operation causes a sharp increase in the level of tyre failures : this is instanced in the following comparative figures published in the United States of America.[4]

	Ratio of "adjustments for failed tyres" for equivalent vehicle population
(*a*) Central and Southern States : (higher speeds, higher temperature) / (*b*) North-Eastern States : (lower speeds, cooler temperature)	$\frac{10}{1}$

There is no reason to suspect that similar results would not prevail under equivalent conditions in Great Britain or elsewhere. The moral is that an adequate tyre size must be used in line with published schedules, together with the appropriate inflation pressure. Serious indifference to these principles is bad engineering and, in the long run, false economy. Clearly, if a tyre company has to deal with an unreasonable burden of customer's complaints and dissatisfaction, the cost of doing this must ultimately be included somewhere in the budget.

An understanding of the effects of tyre constructional variables, and of conditions of tyre operation on the rate of tread wear involves some explanation of the abrasive action between tyre tread and road surface.

In most territories where tread wear is rapid enough to necessitate purchasing new tyres several times during the life of the car (the United Kingdom comes into this category), wear due to cornering constitutes the major factor.[5] It has been shown that when, in a normal cornering operation, the tread rubber is deflected at an angle (slip angle) away from the plane of the wheel, only small amounts of slip or creep are involved in this sideways deflection : it is in the region at the back of the contact area where the tread rubber returns to its unconstrained position, that high slip velocities are encountered.[6] A film, taken under a glass roadway, shows the effect clearly ; it is important to note that some of the recovery occurs on the ground, the rest in the air. Elementary deduction from this picture indicates that for any particular conditions of service, the following variables are of prime significance in determining rate of tread wear :

(1) Amount of sideways distortion of each section of the tyre tread (more distortion means a longer path of recovery).

(2) Duration and slip velocity of each element of tread still in contact with the ground, when returning to natural position.

(3) Abrasive resistance of tread rubber, under slip conditions imposed by (2).

A great many factors, some relating to tyre design and others to vehicle operations, affect the above items, namely :

(1*a*) *Overall Sideways Stiffness.*—Cornering power determined essentially by the overall bending stiffness of the tread/shoulder region of the tyre, in the plane of the ground. The principal tyre constructional features affecting dry-road cornering power are the cord-bias angles in the casing, whether or not reinforcing breakers of high modulus material are present, the sectional shape of tyre, and stiffness of tread elements.

Comparative variations in cornering power of normally available car tyres are approximately :

	lb/degree
Normal road tyres	80
Road-speed tyres	95
Braced-tread tyres	120
Tyres for racing purposes	110

It is unfortunate that high cornering power necessarily involves some deterioration in comfort values.

(2*a*) *Duration and Slip Velocity of Recovering Rubber.*—For a given degree of distortion, the path of recovery of the tread rubber for a particular element of the tread pattern is affected by :

(i) Interaction of tread and tyre casing. Braced-tread tyres, which have a very stiff tread

region and very flexible casing, give a long, gradual recovery path, most of which is airborne outside the contact area. Clearly, abrasive action is reduced.

(ii) Tread sectional shape.

(iii) Stiffness of individual tread pattern elements.

(3*a*) *Abrasive Resistance of Tread Rubber Under Cornering Conditions.*—Such abrasive resistance is a complex subject ; let it suffice to say that type of rubber and compounding details have a significant effect.[7] The tyre industry uses the best tread compounds available, and is primarily limited by incompatibility of other tyre properties. The best possible abrasion-resisting compounds tend to have deficiencies in the matter of crack-resistance, tearing and power consumption.

To complete the perspective on rate of tyre wear, it is necessary to list some of the major vehicle, driver, and road variables which in one way or another affect items (1*a*), (2*a*) or (3*a*) and so have a primary impact on tread life :

(*a*) Inadequate size of tyre. A too-small tyre section just has not got the cornering power necessary to limit tread distortion to reasonable limits, and so rate of wear is inevitably disproportionately high.

(*b*) Maintenance of proper inflation pressure.

(*c*) Avoidance of an excessive degree of negative camber as the vehicle rolls. This reduces cornering power and thus increases tread distortion.

(*d*) Good suspension geometry, particularly regarding maintenance of wheel alignment under cornering and braking conditions.[5]

(*e*) Clearly, driving habits play an extremely significant part in determining the degree of distortion suffered by the tyre treads. It is common knowledge in the tyre industry that a range of 5 or 6/1 in tyre tread life is obtained between the " highest " and " lowest " of a representative cross-section of drivers, for a given car model.

(*f*) Roads with abrasive surfaces and frequent curves accentuate tread wear. As an example, a particular car model gave the following average tread life mileages in the United Kingdom and the United States:

United Kingdom with winding roads, 15,000.

United States with faster, straighter roads, 25,000.

(*g*) Climatic variations such as wet road surfaces compared with dry, or the incidence of snow and ice, reduce tread wear by varying degrees.

Looking at this field from the widest perspective, it is more important to have roads with a maximum degree of safety regarding resistance to skidding, than to have less abrasive, but more slippery surfaces.

TYRE-ROLLING RESISTANCE

When a tyre rolls along the road it consumes power due to the main causes of hysteresis loss in the materials of the tyre, and friction between tyre and road. The latter item is of secondary importance on hard surfaced roads, so that under conditions of normal motoring the rolling resistance of tyres arises almost wholly from hysteresis losses as the tyre is deflected in the area of ground contact. At the higher road speeds, the onset of abnormal distortions of the tyre tread and casing due to the well-known ripple effect increase substantially the overall hysteresis losses and also the ground-friction losses. Recent work by Novopolsky, of the Research Institute of the Russian tyre industry, gives a breakdown of tyre losses in the speed range 80–95 m.p.h. as 90–95 per cent—internal hysteresis, 2–10 per cent—surface friction, 1½–3½ per cent—air friction.[8]

Before considering the effects of variations in construction and materials on tyre-rolling resistance, it is necessary to obtain some perspective of the relationship between the power losses in tyres, and those concerning the vehicle as a whole. Using information from Webb[9] it can be shown that for a typical 10 h.p. car, total elimination of the tyre losses in the region of 30 m.p.h. reduces fuel consumption by only about 20 per cent. More practically speaking, tests have shown that for a change of x per cent in tyre-rolling resistance, fuel consumption changes about $x/6$ per cent for steady speed running up to 50 m.p.h., and by about $x/10$ per cent for normal motoring involving acceleration, braking, hill climbing, &c.

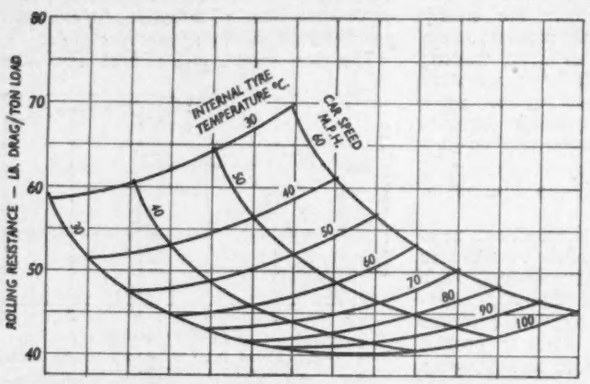


Fig. 5—Relationship between rolling resistance, vehicle speed and internal temperature for typical car type of tyre

The inference from this perspective is that although the tyre designer has an obligation to keep rolling resistance as low as is reasonably possible, a change of a few per cent up or down is not very significant when judged against other performance changes of a bigger and more tangible nature. This is an important point when considering the effective use of synthetic rubber compounds in tyre treads. Typical comparative rolling resistance values for town speed running for possible tyre tread materials are :

(1) Natural rubber compounds, 100–110.

(2) Currently used synthetic rubber compounds 125–150.

(3) Possible butyl rubber compounds 160–170.

At open-road cruising speeds, the effective differences are less, and under motorway cruising conditions there is little practical difference between tyres made from these rubbers. This is because the tyres with the lower resilience materials run hotter, which effectively slows down the rate of increase of rolling resistance with speed. The dependence of tyre-rolling resistance on internal tyre temperature is typified in Fig. 5 which relates rolling resistance, speed and running temperature for a normal car type of tyre.

From the standpoint of town speed rolling resistance, the synthetic materials are not encouraging ; yet because of significant advantages in tread life, wet-road grip and tyre squeal, synthetic rubber has virtually displaced natural rubber from automobile tyre treads. On the more powerful type of car there is a possible future for butyl tyres, in spite of poor hysteresis properties, because of even more marked gains in road holding, silence, and comfort. Indeed, each of these gains appears in some way related to the actual hysteresis properties of the rubber. However, from the consideration of tyre construction, the tread materials have the dominant effect on rolling resistance, with the casing materials exercising only a secondary effect.

Where it is necessary to reduce rolling resistance by changes in tyre construction, it can only be achieved by limiting the radial deflection under load, which naturally affects the comfort adversely. Most road-speed and low-rolling resistance tyres obtain this increased radial stiffness by making the casing cords follow a path near to circumferential round the periphery of the tyre. In the case of the road-speed type of tyre, for example, compared with the standard road tyre, typical differences in construction and deflection are :

	Angle at which casing cords cross tread centre-line	Casing material	Comparative deflection
Road speed ...	30–32 deg. ...	Nylon ...	94
Standard	36–38 deg. ...	Rayon or nylon ...	100

The road rolling resistance relationships are shown in Fig. 6. These graphs indicate that the most significant gains in the road-speed type of tyre are at the top end of the car performance-speed range ; the rapid increase in power consumption which occurs as tread ripple is approached is delayed by about 15–20 m.p.h., preferably to a figure above which any particular car is unlikely to be driven for more than a few minutes. It is obviously inefficient from both the standpoint of car performance and fuel consumption to have the tyres absorbing 8–10 h.p., and so far as the tyre is concerned it is catastrophic ; absorption of energy at that rate can only last for a short time before overheating and disintegration of the structure takes place, usually by the tread parting from the casing.

A very important item when considering the performance of road tyres at high average speeds concerns the stabilisation of the shape of the tyre-ground contact patch, and of the uniformity of contact pressure inside it. Normally, the combination of high running temperatures plus high radial stresses due to centrifugal force starts to reduce the effective working part of the contact area at speeds of 80 m.p.h. and more. A tyre casing material which largely counteracts this effect is nylon ; this material has a heat-retraction property which effectively restricts the centrifugal growth of the tread and so maintains the running efficiency of the contact area. (See Fig. 7). Nylon is, by virtue of its strength, its good bonding with rubber characteristics, and because of this heat-retraction property, an extremely suitable material for the road-speed type of tyre.

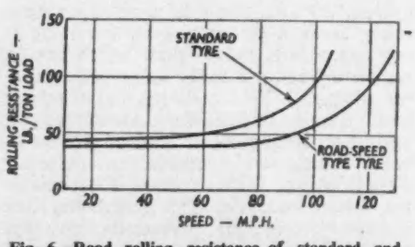
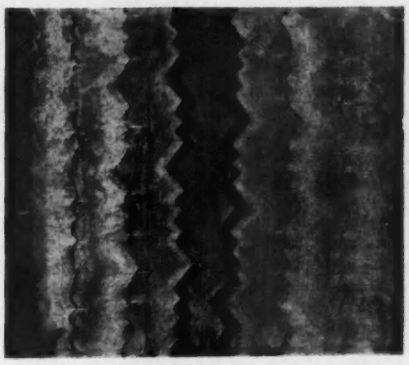
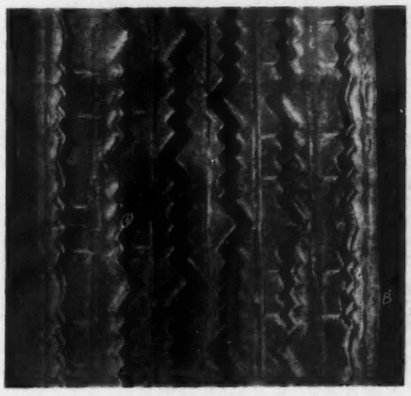


Fig. 6—Road rolling resistance of standard and road-speed type tyres under equilibrium conditions at schedule load and inflation pressure



(*a*) Rayon



(*b*) Nylon

Fig. 7—Tyre contact prints at 100 m.p.h.

The rigid-breaker tyre, by virtue of its stiff undertread breakers, gives a good high-speed performance ; under limiting conditions, it is the flexible casing adjacent to the breaker edges which usually fails.

DISCUSSION

Mr. G. Bastow (Rolls-Royce, Ltd.) : It was suggested that comfort was the primary quality of a tyre, but how was its performance in this respect to be measured ; his firm had found no satisfactory method of test ? Inflation pressures were tending to rise, and there seemed to be good reason to adopt low profile tyres ; in this direction French practice was particularly advanced. He believed that an under-tyred car was recognised not by bad tyre performance over many miles but immediately by bad handling ; cornering power must suffer if the tyres were too small. Tyre squeal was objectionable unless the tyre was being very highly stressed, but, in fact, tyres which had had hard usage squealed excessively. He would wish to halve the average steering wheel forces given on page 254. A particular danger on fast roads was that above 60 m.p.h. a slow puncture could cause a complete loss of pressure without the driver noticing any malfunction ; there was a need for a tyre failure monitor.

Mr. Bastow performed a demonstration intended to show the effect of internal hysteresis in rubber. On a lubricated, inclined plane he placed two sledges, one shod with natural and the other with butyl rubber ; when a heavy weight was placed on each in turn, the natural rubber one only slipped rapidly.

Response.—The change in friction demonstrated is not wholly attributable to hysteresis in the rubber ; if it were, a full-scale experiment would vaporise the tyre ! A pressure above 24 lb per square inch indicated an overloaded tyre, and pressures over 30 lb per square inch were not suitable for normal use. The softening of a tyre as it was run-in did increase the liability to squeal as well as the self-aligning torque.

Mr. D. C. Hartley (Avon India Rubber Company) pointed out that some years ago it had been reported by Gough that best results were obtained with a moderate number of knife-cuts (sipes) in a tyre ; did the very large numbers advocated by the author improve grip or merely noise and appearance ? What was the nature of the straight-ahead test of resistance to wheel spin ? He considered that the operator should not be called on to vary tyre pressures for different duties, and that to ask this implied that the tyres were too small ; low-profile tyres might be more tolerant.

Response.—There were " available " test results showing a 15 to 20 per cent improvement in tractive and braking effort with the pattern of sipes now used. The straight-ahead test was performed by adjusting a throttle stop to find the torque that would spin one wheel ; the results correlated well with braking measurements. Low-profile tyres were certainly better to meet large variations in speed.

V. E. Gough (Dunlop Rubber Company, Ltd.) : The work he had done many years ago on the influence of sipes was based on smooth asphalt surfaces ; there were now many surfaces which were microscopically smooth but macroscopically rough, composed typically of knobbly, polished stones, and on these surfaces many more sipes were advantageous. Referring to Mr. Bastow's demonstration, he asked why the unloaded sledges had not slipped. He had found that the static friction of rubber differed according to its composition and according to the uniformity of contact ; observed results were as follows:

On uniform steel surface, natural rubber $\mu=1\cdot2$, butyl rubber $\mu=1\cdot5$; on steel bars $\frac{1}{4}$in wide at $1\frac{1}{2}$in centres, natural rubber $\mu=0\cdot9$, butyl rubber $\mu=1\cdot0$. The experiment could be explained by the difference in friction coefficients in conditions of full area contact, without considering internal losses.

Mr. G. C. Giles (Road Research Laboratory) did not agree with the lecturer that adhesion on dry roads was not a primary problem. He could confirm that a large number of sipes contributed to maximum grip in braking, but in the cornering mode adhesion might be lessened. Since the effect of hysteresis on skidding resistance had been demonstrated on a lubricated surface, differences in coefficient of friction might not explain the phenomenon ; if it was to be exploited, it would mean having pimples on the road surface. Assuming that it was desirable for a road to be rough, what order of irregularity was most acceptable to the tyre designer ? Had the cornering tests on actual vehicles been tried on a rough surface ? He considered that part of the difference between tyre lives in this country and the United States of America was due to the roads in that country being dusty.

Response.—Some control over grip on a dry road did exist ; racing tyres showed higher grip. Sipes had some tendency to weaken the tread, particularly on a smooth tyre. Irregularities on the surface should be no larger than necessary to drain off water. Not enough work had been done on the behaviour of tyres on irregular surfaces, and Dunlop was now contemplating both track and test machine work with the tyre hopping. Tests on full-scale tyres gave the following values for maximum adhesion : butyl rubber, side force 0·81, tangential 0·55 ; synthetic rubber, side force 0·64, tangential 0·48 ; natural rubber, side force 0·55, tangential 0·42.

The chairman expressed his surprise that vehicle designers had for long been denied higher inflation pressures, but last year the Tyre Manufacturers' Conference had recommended an increase in pressure of 6 lb per square inch without any restriction.

A member : In his experience, tyre life on cobbled roads in Germany might be three times as good as in this country. Was the swing axle geometry favourable to tyre life ? What could be done about cracks in the side walls of tyres left to stand for long periods—even if the cracks did not go down to the fabric the operator might be afraid to use the tyre ?

Answer.—Tyre lives were certainly better in Germany : this country was particularly hard on tyres because of the winding nature of the roads, and cobbles did not cause tyres to wear. Tyre wear was sensitive to attitude in the steering rather than the camber sense, and swing axle geometry was quite acceptable, as had been demonstrated by the V-W. Deterioration in standing was likely to be less serious with butyl rubber, and for this reason the United States armed forces were interested in it ; another solution might be found in the use of coatings of jelly consistency to keep the tyre from contact with air.

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British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 2, Park Street, London, W.1

MECHANICAL TESTING OF STEEL AT ELEVATED TEMPERATURES : PART 2 : STRESS RUPTURE

No. 3082 : 1959. Price 4s. This new publication forms Part 2 in a series of British Standards which will deal with the mechanical testing of steel at elevated temperatures. It is based on the work undertaken by Technical Committee 17 (Steel) of the International Organisation for Standardisation as has been tentatively approved by all the member countries represented by that committee. It is hoped that the series will help to facilitate the comparison of different steels at elevated temperatures and to unify the methods by which the data are obtained. In this part, definitions for gauge length, stress and proof stress are followed by requirements for the test piece. Consideration is given to the limits within which the heating apparatus must operate and to the method for measuring the temperature. Other requirements deal with : the accuracy of the testing machine, temperature and stress rupture readings, and with the presentation of results.

POWER-DRIVEN MAST HOISTS FOR MATERIALS

No. 3125 : 1959. Price 5s. This publication specifies requirements for a non-passenger, power driven hoist not exceeding 50 cwt capacity, for temporary use on construction work, in which a platform for lifting materials is supported and guided by a mast. The standard requires minimum safety requirements and that hoist design and testing are, as far as possible, in conformity with cranes in general.

Qualities of material and equipment are specified for all important parts and an appendix lists specified British Standards under five main headings : materials ; structural details ; machinery and machinery details; electrical machinery and equipment ; lifting equipment. Another appendix summarises nineteen items of information which a manufacturer should supply with a tender.

Aerial Exchanges at Admiralty W/T Station

A system is described for connecting any one of several transmitters to different aerials according to the service to be provided, using motor-driven terminal carriages running in horizontal and vertical guides. An identical exchange has just been installed at Singapore, and an equivalent scheme for use with coaxial feeders is in the design stage.

THE range of long-distance point-to-point and broadcast services handled by the Admiralty wireless telegraphy station at Inskip, near Preston, Lancs, necessitates a rapid and flexible system for interchanging connections between the transmitters and the various groups of aerials. For this purpose two transmission line exchanges are installed, one at each end of the main transmitter hall. Each exchange is capable of connecting any of ten transmitters to any of twenty aerials, and is operated from a control desk by inserting plugs corresponding to transmitters into sockets corresponding to the aerials on which they are to transmit. The connections are then made automatically by the movement of horizontally- and vertically-travelling carriages on which are terminated respectively the transmission lines from the transmitters to the exchange, and from the exchange to the aerials.

These exchanges, designed and built to Admiralty requirements by P. and L. Miller, Ltd., Heneage Street, Brick Lane, London, E.C.1, are the latest development of the same firm's equipment described in an earlier form in our October 3, 1952, issue. At that time, however, only the horizontal carriages were motor-driven (although provision was made for motor drive to the vertical carriages), and the electrical controls were not assembled on consoles. The system in operation at Inskip has not only centralised the control of each exchange, but enables any connection to be set up by a single action on the operator's part, the sequence of events and accuracy of positioning of the carriages being governed automatically by micro-switches.

Inskip station is equipped with thirty transmitters ranging in output power from 40kW to 3½kW, and covering frequencies between 4 Mc/s and 28 Mc/s. Twenty of them were supplied by Marconi's Wireless Telegraph Company, Ltd., Chelmsford, Essex, and ten by Standard Telephones and Cables, Ltd., Connaught House, Aldwych, London, W.C.2. Both companies were also concerned in the supply of drive units for the transmitters and much other radio and associated apparatus. Traffic does not originate at Inskip, but is received over three coaxial cable links providing a total of fifty-four channels. Transmissions are mainly in teleprinter code, although certain broadcasts are sent in automatic hand-speed Morse.

A general arrangement of the form of aerial exchange installed at Inskip is shown in Fig. 1. In front of the control desk is a tower structure on which the fixed feeders from the transmitters are terminated and connected to the swivelling feeders running to the horizontal-travelling carriages on the semi-circular exchange framework. The drawing also shows the pillars which guide one of the vertical carriages and the connection therefrom to a lead-out insulator. In this diagram the lines are transposed from the vertical to the horizontal plane between the tower and the carriage, but local conditions may make it necessary for the feeders to be horizontal throughout, and this, in fact, is the arrangement at Inskip.

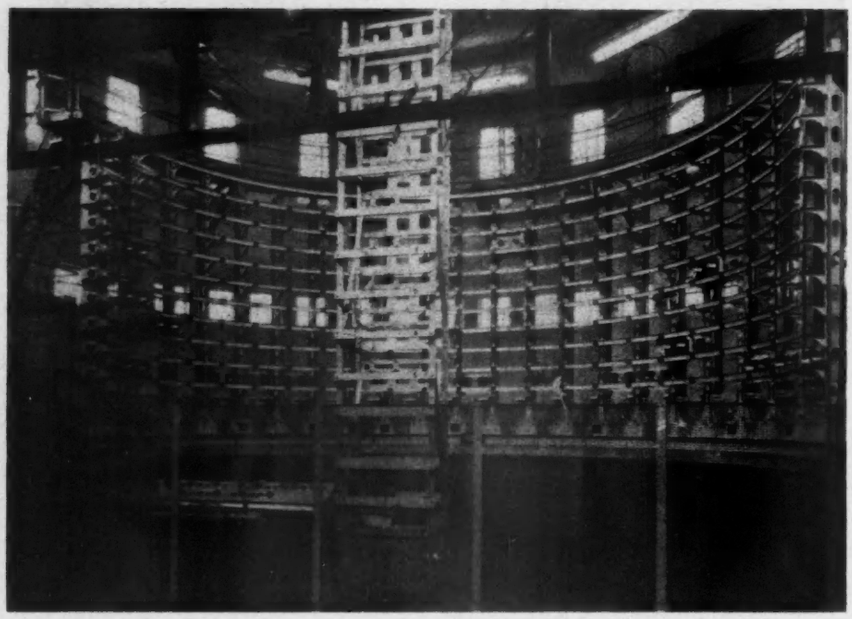


Fig. 2—One of the aerial exchanges at Inskip, showing operator at control console in foreground

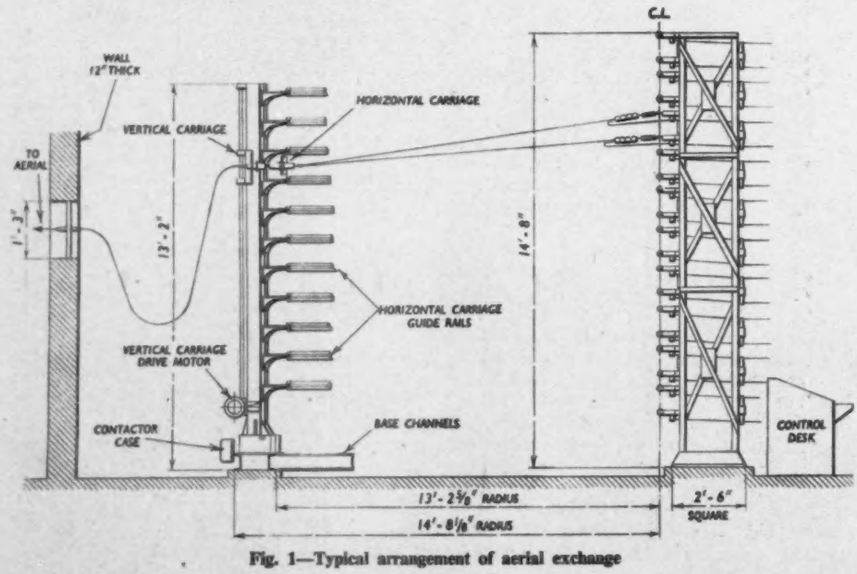


Fig. 1—Typical arrangement of aerial exchange

In either case the uniform spacing of 10in between the lines is preserved so that there is no change in the characteristic impedance of 600 ohms.

At Inskip each exchange is erected in a semi-circular extension of the transmitter hall, the outer wall having an internal radius of 20ft and the ceiling a height of 25ft 6in. The exchange framework is built on a 180 deg. semi-circular wall, 4ft 6in high and 1ft 6in wide at the top, as can be seen in Fig. 2. This provides a safe clearance between the lowest pair of feeders and floor level. The framework uprights consist of twenty-two columns of 6in by 4in cross-section and approximately 12ft 6in high, supported by cast iron plinths with adjusting screws in three planes to ensure accurate positioning and verticality.

The chordal pitching of these columns is 23·8in, so that they form twenty-one bays approximately 20in wide. Each pair forms a slideway for a vertically-travelling carriage, the slideway surfaces being precision ground. From these columns are mounted eleven semi-circular horizontal rails of high-duty aluminium alloy with a specially extruded section. The rails are spaced at 1ft vertical intervals and form ten horizontal trackways.

Into every vertical bay except that at the extreme left is fitted a carriage measuring

approximately 22in by 12in and equipped with guides machined to such close limits that it will slide from top to bottom of the columns with negligible side play. Into all ten horizontal tracks are fitted carriages mounted on ball-bearing S.R.B.F. wheels. All carriages, both horizontal and vertical, carry a pair of insulator-mounted phosphor-bronze contacts of approximately 1in diameter spaced at 10in centres. On the vertical carriages only, the contacts are spring-loaded so as to maintain pressure on the mating contacts of a horizontal carriage when the two carriages are moved into coincident positions in order to provide a through connection from a transmitter to an aerial.

Feeders spaced at 10in are brought from each of the twenty aerials through windows in the wall of the building at a mean height and thence to the vertical carriage contacts in such a way as to form a hanging loop between the wall and the exchange structure.

The tower structure at Inskip is of steel and wood construction and measures 3ft by 2ft 6in by 15ft. Lines from the transmitters are taken through insulators on both sides of the tower to preserve accurate spacing, and on the exchange side are looped back and spliced to the lines which continue to the horizontal carriages. The latter lines terminate at the tower end on insulators which are anchored through springs, to maintain tension, to pivot mountings allowing movement in the horizontal plane.

Vertical Drives

At the base of each column is mounted a Simmonds ¼ h.p., 1440 r.p.m., three-phase, 50 c/s motor coupled to a gearbox incorporating spur and helical gear trains (Fig. 3).

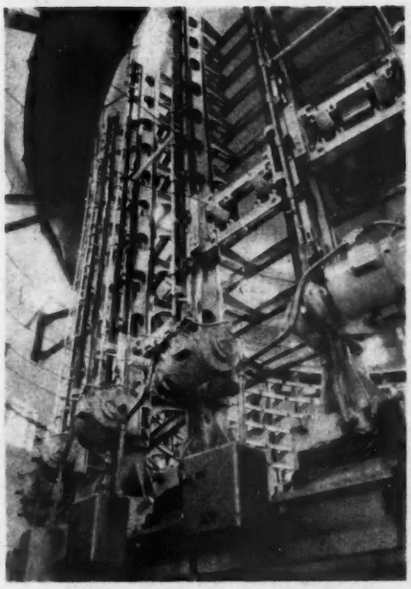


Fig. 3—Vertical drive motors and aerial feeder carriages at rear of framework

The vertical output shaft is then coupled to a high-tensile lead screw, 12ft long, 1¼in diameter and 16 t.p.i., which passes through a nut on the corresponding vertical carriage and is suspended from a bearing housing at the top of the column. By the operation of a reversing contactor and limit switches the vertical carriage can thus be driven up or down the column to any of ten positions corresponding with the horizontal carriage tracks. The speed of the lead screw is restricted to 300 r.p.m., which is just below its natural frequency.

Horizontal Drives

Ten motors similar to those for the vertical drives are mounted on the extreme left-hand column of the exchange framework (Fig. 4) and are each directly coupled to a

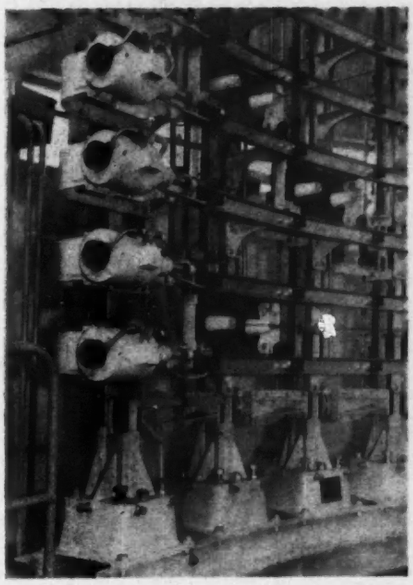


Fig. 4—Horizontal drive motors and transmitter feeder carriages, two of which are in the "rest" position and the third in contact with an aerial feeder carriage

flexible "Teleflex" lead screw of approximately $\frac{7}{16}$in lead. This is contained in a recess which runs the entire length of the upper surface of each horizontal rail. Each horizontal carriage is equipped with a spring-loaded half-nut which engages with the lead screw. By a similar system of reversing contactors and limit switches to that of the vertical drives, each horizontal carriage can be driven to any of the twenty positions coinciding with the vertical carriageways, or to the extreme left-hand bay of the structure, in which the carriage contacts are earthed. The horizontal motors drive through torque limit clutches and are equipped with electromagnetic brakes for accurate positioning of the carriages. Reversing contactors for all drives were supplied by British Klockner, Ltd.

Control System

The exchange is operated from a control desk on the face of which are two rows of flush-mounted sockets, twenty in the upper row and ten in the lower row. Each socket in the upper row represents one aerial. Ten plugs, each representing a transmitter and individually wired so as to control a particular horizontal carriage, rest normally in the lower row of sockets. When a plug is in this position its associated carriage is at rest and earthed at the extreme left of the exchange and a white indicator lamp against the socket on the panel is illuminated. When the plug is placed in an aerial socket, a circuit is made to the reversing contactor controlling the motor which drives the horizontal carriage of the transmitter concerned, via a position switch corresponding to the aerial to which the transmitter is to be connected. These conditions obtain, however, only when the transmitter is "off," for when a transmitter is switched on, a relay with its contacts in the control circuit to the reversing contactor is energised and the contacts open to isolate the contactor. A red "transmitter on" lamp is also illuminated.

Assuming the transmitter to be "off," the horizontal carriage is driven from left to right, operating successive position switches as it traverses them by means of its switch trip plate, but without further action until it reaches the switch in the circuit which has been energised. When this switch is operated, the contactor is tripped and the electromagnetic brake on the motor shaft is energised simultaneously so as to bring the carriage to rest. At the same time the motor driving the vertical carriage corresponding with this position is started and the vertical carriage is driven upwards until its contacts mate with those of the horizontal carriage, the positioning being controlled by similar position switches. The control circuits for each exchange at Inskip contain 440 Burgess micro-switches and 6 miles of cable. The approximate weight of each exchange is 8 tons.

When a transmitter has been switched off, removal of the corresponding plug from the aerial socket and its replacement in the appropriate socket in the lower row causes the horizontal and vertical drive contactors to be energised so that the motors run in the opposite direction and both carriages return to their "home" positions, in which they are earthed. In this condition the transmitter is inoperable. All control circuits operate at 50V d.c. so that there is no mains voltage at the control desk. The ten transmitters connected to each exchange are selected from a group of twelve by means of additional plug and socket connections on the panel, thus enabling any two transmitters to be set aside for inspection and maintenance.

Electronic Telephone Exchange

On January 21 and 22, the Laboratoire Central de Télécommunications, Paris, an associate of Standard Telephones and Cables, Ltd., London, invited representatives of the principal French Ministries and other official organisations to a demonstration of a 240-line fully electronic telephone exchange in operation. The exchange embodies the results of studies and research carried out since 1945.

In the normal electromechanical exchange a large number of identical control devices are available for individual allocation to subscribers dialling numbers. The principle of the electronic exchange, on the other hand, is that a single circuit, containing no moving parts, is permanently at the disposal of all subscribers for the establishment of connections. This "logic" circuit can receive calls from 240 subscribers and handle them at the rate of sixty a second. Switching is accomplished by transistors operating with a switching time of less than 1 microsecond, or 10,000 times faster than electromechanical devices at present in use.

At the demonstrations a review of electronic developments in recent years was given by Prince Louis de Broglie, Secrétaire Perpetuel de l'Académie des Sciences. The principal characteristics of the electronic exchange were explained by Professor G. Goudet, manager of the Laboratoire Central de Télécommunications, who emphasised the advantages of reliability inherent in using devices such as transistors and new magnetic materials which do not wear and have practically unlimited life. The exchange, which handles all the traffic of the 240 telephone extensions throughout the laboratory, is the second to be established in Europe, coming two years after the twenty-line electronic automatic exchange, also designed and constructed by the laboratory, which is at present in use on board a ship of the French Navy.

LITERATURE

Mechanisms and Motions. By K. H. HUNT. The English Universities Press, Ltd., 102, Newgate Street, London, E.C.1. Price 21s.

IT is a recurrent complaint that the teaching of the subject of "Mechanisms" has not advanced with the times and that in this country we have not taken sufficient notice of developments of the basic theory of mechanisms on the Continent of Europe. This book is one of which the complainers should approve even though they may have divergent degrees of supplementary commendation.

The common practice of illustrating some theoretical principle by a numerical calculation based upon it is to be commended. The practice of adopting for this purpose problems that can be solved more easily by less advanced methods has advantages and disadvantages. It enables the student to satisfy himself that, for that particular example at least, the advanced method gives the right answer. On the other hand he may tend to wonder whether there may not be a simpler alternative to every use of the method, and whether in fact it is worth studying.

In the present work, the author considers an aircraft flying round the earth at constant air-speed and at constant height above sea level in the plane of the equator, first in one direction and then in the opposite direction. He asks whether the change in direction produces any change in useful load-capacity and contrives to bring in the Coriolis force. He afterwards asks the reader to check his answer by considering the "absolute" velocity of the aircraft without defining "absolute." If one takes it to mean "relative to the fixed-star system" and assumes centrifugal force to be equal to the product of the radius of the circular path of the aircraft (relative to the earth) and the square of the angular velocity (relative to the fixed-star system) of the line that joins the mass-centre of the aircraft to the centre of the earth, one obtains the same result as the author does. One might conclude from this that this procedure was what the author intended. If so, he might perhaps have commented on the question as to why the fixed-star system, rather than any other, should be selected for this purpose.

The book devotes considerable space to abstract basic theorems in mechanisms but many of the exercises are practical enough, are interesting, and are valuable to the student. In dealing with the Five-Bar Group Problem the author refers to Stephenson's Link Mechanism as "an inversion of an identical type of Six-Bar Chain." This would probably have surprised the inventor of the mechanism, although not to the extent of frightening him off. Very few subsequent designers of mechanisms of this character have found any need for anything more erudite than the use of ruler and compasses for assessing tentative layouts based on what has been done before.

The author's application of the description "Space Mechanisms" to mechanisms that cannot be represented by points in a single plane has the advantage that it is shorter than "Three-Dimensional Mechanisms" but is unfortunate in its faint suggestion that plane mechanisms are not in space. One is reminded of the quaint practice of describing points that are not in or on the actual material composing a machine or structure as being "in space" whereas "in air" would be more appropriate if any comment is required at all.

While rigorous analysis of the operation of some mechanisms is laborious and even tricky, formal synthesis is usually difficult and often impossible. The author recognises this and also draws attention to the importance of practical considerations in manufacture and in service although they are outside the nominal scope of this book which is that of kinematics. He implies (rightly) that synthesis of a mechanism for any particular purpose usually demands repeated trial but shows admirable restraint in refraining from suggesting that this is yet another field for the application of electronic "brains."

This book is one of a series intended primarily for students for engineering degrees. It constitutes an introduction to the subject and, although it is unconventional in its treatment, it is not to be criticised on that account.

Property Measurements at High Temperatures. By W. D. KINGERY. John Wiley and Sons, New York. Chapman and Hall, Ltd., 37, Essex Street, Strand, London, W.C.2. Price 132s.

THIS book carries the sub-title "Factors Affecting and Methods of Measuring Material Properties at Temperatures above 1400 deg. Cent. (2550 deg. Fah.)," but this does not mean that the contents are of no interest to those who may be concerned with lower temperatures. Low temperature techniques that can apply to high temperatures are described as well as special ones for high temperatures. It emerges that as the temperature level is increased, simpler techniques become more suitable, and in particular that techniques that do not require extensive manipulation become advantageous. It is shown that no one method is "best" but that each case has to be considered on its merits. The range of subjects covered is comprehensive and this applies to the liquid state as well as to the solid. Methods for the determination of viscosity, surface energy and electrical conductivity are all detailed. Most of the book is concerned with the solid state, however, and, because of the high temperature, it is mainly non-metals which are discussed. The chapter on laboratory furnaces is particularly useful for those concerned with this kind of work, and the merits and limitations of the various types are described at length.

At the beginning of each chapter there is a table entitled "Major Symbols used in the Chapter" and, since this covers most of the page, it is a little disconcerting. However, many of the symbols turn out to be familiar and it certainly is an arrangement which disposes of all ambiguity. Mathematical treatment is kept to a minimum and where it occurs it is well presented and easy to follow. If the need arises, the author is prepared to state his opinion without qualification, e.g. "For non-metals, tensile tests are not recommended" (page 166); one may not agree with him on all occasions, but the intention to give clear guidance is to be applauded. Where excessive detail would confuse the presentation, the reader is referred to other sources by references. These references, grouped under headings at the conclusion of each chapter, have been collected and arranged with care and they constitute an excellent bibliography of the subject. There is a detailed contents list at the beginning of the book, and subject and author indexes at the end.

The forgivable number of misprints will no doubt be put right in the next edition. Then the opportunity should also be taken to arrange that, wherever possible, the discussion of a diagram adjoins the diagram itself. However, these are small matters in relation to the book as a whole, which is to be thoroughly recommended to all having occasion to work at these temperatures. The book is remarkably up to date.

Trockner und Trocknungsverfahren. By K. KROLL. Berlin–Göttingen–Heidelberg: Springer - Verlag: Berlin - Wilmersdorf, Heidelberger Platz 3. Price DM.69.

THE second volume of *Trocknungstechnik* by O. Krischer and K. Kröll has now been published. While Volume I deals with the theoretical basis of drying, the present work is concerned with actual designs suitable for various applications, their layout and energy consumption. The vast extent of the field considered here made it necessary to concentrate upon typical designs and their application to some of the most important materials. In spite of this self-imposed restriction, the twenty-five page subject index quotes references to some 500 materials and groups of substances! At first sight the process of drying may appear a simple matter involving nothing more than the removal of water (or other moisture). The situation is very much complicated not only by the physical shape and state of the manifold articles and substances which are to be dried, but by a variety of secondary processes, which are sometimes desirable, but more often involve to a greater or lesser degree an objectionable physical alteration or chemical denaturation.

After reviewing the technical principles of dryers and their planning and design, the author discusses these changes of which the effects have always to be carefully considered. A substantial section next deals with drying plant based on the principle of pure convection, discussing as particular applications the drying of wood, paper, cardboard, leather, textile fibres and fabrics, ceramics, foundry moulds and cores, lacquered articles, and others, as well as bulk materials at rest, in turbulent blown layers, moving in other ways in the drying atmosphere; a special subsection deals with cereals, foodstuffs, and fodder.

In many plants efficient operation depends on removing moisture from the air before it enters or before it is recycled, or reclaiming any solvents removed in the drying stage. These matters are briefly discussed, after which the author turns to a consideration of two further important groups of dryers, those depending on radiant energy and those where the heat of evaporation is imparted by direct contact with heated surfaces (containers, tubes, cylinders, rollers). Very often, the heat is applied in two or more

ways simultaneously, and the goods are turned over, vibrated or stirred in order to speed up the process ; equipment involving such principles is considered next.

While most substances can be dried by one or the other of the foregoing methods, there remain two classes of process which in their respective fields of application give results not otherwise obtainable. Vacuum drying is resorted to in order to speed up the drying process and carry it further than is normally possible in such special applications as the removal of moisture from electrical insulations, e.g. during the manufacture of transformers. Much higher vacua are employed in the so-called freeze-drying techniques where the material to be dried is either pre-frozen, or frozen by the removal of latent heat from partial evaporation of the moisture content in the vacuum. In these cases, the bulk of the water sublimates directly from the ice into the vapour phase, being removed by absorbents, pumps or low temperature condensers. It is characteristic of this method that it occasions a minimum of damage so that sensitive organic and biological preparations, such as blood serum and plasma, bacterial cultures, and live tissues may be freeze-dried, and later re-constituted for use by simply adding water. The other method referred to is the application of alternating electrical fields. The final chapter is devoted to the automatic control and regulation of drying plant.

Corrosion and Deposits in Coal and Oil Fired Boilers and Gas Turbines. The American Society of Mechanical Engineers, New York. Pergamon Press, Ltd., 4 and 5, Fitzroy Square, London, W.1. Price 50s.

THIS publication has for its objectives the presentation of a critical summary of all available information on the deposition of solids and the corrosion of metals on the gas side of boilers and gas turbines, and the definition of further research needed. The result is a very useful reference book, which covers all aspects of the problem in both coal and oil fired installations. Over 400 literature references are given, which indicates the volume of work which has been carried out in this field over the past decade.

In spite of this impressive research effort, it is evident that no universal remedy for these troubles has been forthcoming. Possible treatments are also severely limited by costs, particularly in the case of residual fuel. Any remedial measure must be cheap, otherwise the economic advantage of using a residual fuel oil is lost. It has been estimated that the cost of treatment should not exceed about 10s. per ton of fuel oil. These considerations have prevented the wide use of residual fuels in gas turbines to date. With the trend to higher steam temperatures in boilers, the problem is becoming more acute in this field and may become a limiting factor.

It is timely, therefore, to consider what further research is needed, and the report does a valuable service in pointing out the gaps in our knowledge. Much fundamental work remains to be done on the mechanisms of deposition and the formation of corrosive compounds. However, in some cases, particularly the field of additives for the alleviation of ash fouling and corrosion in gas turbines, experiment is ahead of theory. Almost every element in the Periodic Table has been tried on an empirical basis, without notable success, and it is difficult to see how further academic research would effect an improvement in the situation. There seems more hope for the suppression of sulphuric acid formation.

It remains to be seen whether a more fundamental approach will succeed, where a large amount of virtual trial and error has failed.

Initiation aux Processus Aléatoires. By M. GIRAULT. Dunod–Editeur, 92, Rue Bonaparte, Paris (6e). Price Fr.980.

THIS little book which belongs to a collection entitled *Probability, Statistics and Operational Research*, directed by M. Darmois, is the first of the Operational Research group. Under the title of an introduction to random processes, it studies in the main the behaviour of queues for which arrivals in time form a line obeying the Poisson law. This law has the following essential characteristics :

1. Independence of arrivals from each other.
2. Independence of arrivals in relation to the time of arrival.

In these conditions, and following the conditions of the service provided for the end of the queue (number of gates and length of time at the gates), the author shows that one can calculate certain essential values for the system, such as the average length of the queue ; the distribution function for the delay time ; the average delay time ; and the law governing the length of time spent at the gate. The calculations are relatively easy when the length of time of service rendered to each element in the queue obeys an exponential law, but become much more complicated for other simple laws such as a constant time of service per individual.

This homogeneous group of calculations is placed in a framework which allows one to judge in a more detached manner the nature of the stochastic processes and the general concepts which lie behind their structure. The author concludes with the statement that his purpose has been to give a broad view of the possibilities of this branch of theory to encourage the reader who may be faced with more complex problems to study these developments more deeply.

Principles of Electronic Instruments and Instrumentation. By GORDON R. PARTRIDGE, Ph.D. Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, London, W.C.2. Price 40s.

THIS book is based on the notes used by the author in a course of post-graduate lectures at Purdue University, and has appeared previously in the United States under the title of *Principles of Electronic Instruments*. Chapters 1 to 11 cover voltmeters, electrometer tubes and circuits, wattmeters, phase and frequency measurement, and component testing, together with a review of feed-back and its benefits in the instrumentation field. Chapter 12 is on digital display and introduces various forms of counting circuit. The last seven chapters are concerned with mechanical measurements, velocity, time, sound, light, pressure and temperature, and radioactivity. In his preface the author states that he has mixed many forms of mathematics together liberally and has drawn upon them as required to explain the operation of a circuit. The result is an occasional abrupt transition from a simple account of how a basic theoretical circuit works, to a much more refined analysis of a practical scheme. Some readers relatively new to electronics may therefore find difficulty in following the author more than half-way, having missed a link in his argument or being unaware of some fact of which a knowledge is assumed. This is no drawback in the lecture room for which the author's notes were designed, but it is liable at times to disconcert the private reader. However, despite the remarkably wide range and variety of electronic instruments to-day, the reader will find in these pages an equivalent of most of those with which he comes in contact and will be assisted both in his understanding of electronic instrumentation and in his appreciation of the uses to which these devices may be applied.

Surveying. By A. BANNISTER, A.M.I.C.E. and S. RAYMOND, A.M.I.C.E. Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, London, W.C.2. Price 45s.

HERE we have a textbook of the basic facts of surveying, up to the standard needed for the B.Sc. or similar examinations. The subject matter is arranged much in the manner which would be expected, the chapters covering chain surveying, levelling traverse surveying, &c., until we reach the final chapters on photogrammetry, field astronomy and theory of errors respectively. The text is businesslike and as concise as the presentation of detailed explanation allows. An unusual point is the inclusion of a chapter on hydrographic surveying.

The authors point out that there has been less research in surveying than in other civil engineering subjects in recent years, but nevertheless a surprisingly large number of new developments have taken place, and one of their aims has been to acquaint students, from the start, with as many of these new developments as possible. Thus the book includes brief mention of an instrument as new as the tellurometer, and devices such as the " Microptic " theodolite and the Zeiss automatic level are described. It is unfortunate, however, that reference to the new British self-aligning level (which was described in THE ENGINEER on January 23, 1959) is omitted.

Viscosimètre Balistique. By F. CHARRON. Publications Scientifiques et Techniques du Ministère de l'Air, No. 350. Service de Documentation et d'Information Technique de l'Aéronautique, Magasin C.T.O., 2, Avenue de la Porte-d'Issy, Paris (15e). Price Fr.430.

THE publication describes an instrument for measuring viscosity by the measurement of a single linear displacement. The change in momentum of a slowly flowing quantity of liquid pumped through a capillary tube by a small piston causes a displacement of the piston, which is measured. Experiments are described involving the use of liquids of a wide range of viscosities from 0·2 to 75 poises.

Books Received

Science in Industry—Policy for Progress. By C. F. Carter and B. R. Williams. Oxford University Press, Amen House, Warwick Square, London, E.C.4. Price 21s.

Nomography. Second Edition. By Alexander S. Levens. John Wiley and Sons, Inc., New York ; Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 68s.

Oxygen in Steel Making. (Bibliographical Series No. 22.) Iron and Steel Institute, 4, Grosvenor Gardens, London, S.W.1. Price (non-members) 37s. 6d.; (members) 25s.

Methods for the Determination of Toxic Substances in Air. By J. C. Gage, N. Strafford and R. Truhaut. Butterworths Scientific Publications, 4-5, Bell Yard, London, W.C.2. Price 30s.

"Triplex" Locomotives

By E. C. POULTNEY, O.B.E.

RECENTLY, in the course of a review of a new book *Modern Railways*, by C. J. Allen, THE ENGINEER had occasion to mention some remarkable locomotives in service many years ago on the Erie Railroad in the United States, thus bringing to mind an interesting, though comparatively little known, development in steam locomotive design and one, moreover, in certain respects reminiscent of some at one time in use on our own railways. In view of the foregoing, the writer ventures to offer a more extended reference to these locomotives of unique design, which can, fortunately, be illustrated by some photographs of considerable historic interest. Those reproduced show, respectively, the first of three built for the Erie by The Baldwin Locomotive Works in 1914, which was followed by a further two in 1916, and the other a similar locomotive, one of which was also built by Baldwin experimentally for the Virginian Railroad about 1917. At the time the first Erie locomotive was built, this railway was faced with a difficult operating problem in handling increasingly heavy freight trains over the Susquehanna grade, extending over a distance of 11 miles from a point 8 miles east of Susquehanna, Pennsylvania.

For this distance the line rises at the rate of 56ft per mile—1 in 95—and powerful locomotives were required for "pusher" services. The general design will be appreciated from the illustration, from which it will be seen that, basically, it consisted of a conventional articulated engine of the Mallet type with a 2–8–8–0 wheel arrangement in conjunction with a second rear articulation to a trailing 0–8–2 type engine which carried the coal and water; in other words, it was no other than an adaptation of Sturrock's steam tender idea, first introduced away back in 1863. Here mention may fittingly be made that THE ENGINEER illustrated one of the later steam tender engines as built at Doncaster in 1865 in a valuable supplement devoted to the Great Northern Railway in the issue of November 28, 1913. Returning to the Erie locomotives, the cylinder arrangement claims attention. There were six cylinders, compounded, all of equal dimensions, as were also the eight coupled wheels, three sets in three separate groups. Compound expansion was attained by using the two cylinders for the centre set of coupled wheels as the h.p. pair and the remaining two pairs as l.p. cylinders.

The exhaust from the right-hand h.p. cylinder supplied the leading two l.p. cylinders through the medium of an intermediate receiver, and the left-hand h.p. cylinder in like manner exhausted to the trailing pair of cylinders, so forming in effect a 2 to 1 compound.

The Baker valve gear was used, operating 16in piston valves for each cylinder, all of which were 36in by 32in. This arrangement of cylinders and wheel grouping provided really three separate engines in one unit; hence the name "Triplex." The boilers of all three engines were generally very similar; that for the first locomotive provided a total of 6886 square feet of evaporative heating surface with a further 1584 square feet by the fifty-three element superheater. The grate area was 90 square feet. It will be observed that the firebox had to be carried above the trailing coupled wheels of the centre engine and, as these had a diameter of 63in, the firebox was, in consequence, much restricted in depth, as was also the ashpan. This is understood to have been the weak point in the design. It is said to have had an effect on the efficiency and reliability of the combustion process which was detrimental to steaming and consistent performance, and, though the engines were only required for the 11 mile climb, it has been said that this distance was just a little too great for properly sustained combustion.

A further feature of these engines was the feed water heating equipment, made up of a long drum fitted below the tank, having thirty-one 2¼in tubes about 25ft long through which the steam exhausted by the rear l.p. cylinders passed on its way to an exhaust pipe at the rear of the locomotive.

The heated feed was supplied to the boiler by two single acting plunger pumps worked by the h.p. piston rod crossheads, one pump being fitted on each side of the locomotive. The principal feature of these notable locomotives is no doubt the use of six cylinders, almost unique in the history of the steam locomotive, though not unknown on our railways. For, some ten years after these Baldwin engines were completed, in 1925 to be precise, Beyer, Peacock and Co. built at Gorton Foundry for the L.N.E.R. a six-cylinder simple expansion Beyer Garratt to the requirements of Sir Nigel Gresley, which, like the Erie engines, was also specially intended for heavy "pusher" service on a 1 in 40 up grade in Yorkshire. This, like the Erie engines, was an outstanding design, fully described in THE ENGINEER of June 26, 1925. In passing, mention may be made of the fact that a feed heater working on much the same principle to that of the Erie engines was used for the Sturrock steam tender locomotives.

The Virginian engine, though similar to the Erie locomotives, differed by being of the 2–8–8–8–4 type, a four-wheeled trailing truck taking the place of the two-wheeled pattern. Its dimensions also differed somewhat. The two later Erie engines had modified fireboxes with a large grate having an area of 121·5 square feet.

It now only remains to say that these remarkable engines regrettably met with only a partial success—they were never duplicated. In conclusion, a few of the main dimensional particulars are appended in tabular form to give a fair idea of the proportions of these engines. The present Baldwin-Lima-Hamilton Corporation furnished the two photographs reproduced.

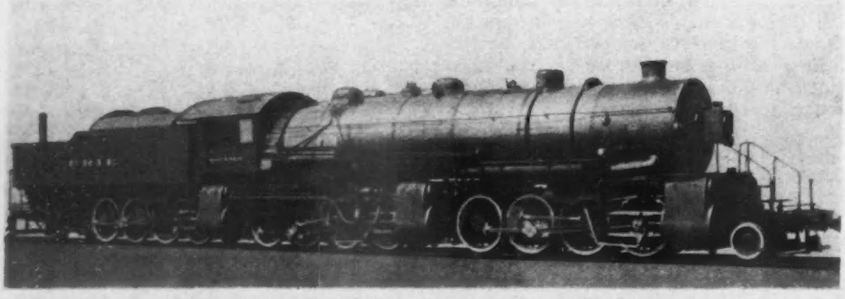


Fig. 1—The Erie "Triplex" 2–8–8–8–2 locomotive, 1914

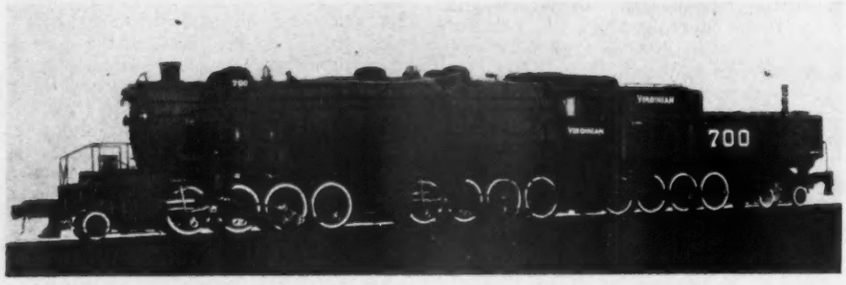


Fig. 2—The 2–8–8–8–4 "Triplex" type locomotive for the Virginian Railroad

Dimensions of "Triplex" Locomotives; Erie and Virginian Railroads

Railroad	Erie	Virginian
Locomotive No.	"Matt. H. Shay" No. 5014	No. 700
Type	2–8–8–8–2	2–8–8–8–4
Cylinders:		
H.p. number, diameter and stroke, in	Two 36×32	Two 34×32
L.p. number, diameter and stroke, in	Four 36×32	Four 34×32
Valve gear	Baker	Baker
Piston valves, diameter, in	16	14
Coupled wheels, diameter, in	63	56
Boiler:		
Steam pressure, lb per square inch	210	215
Heating surfaces, square feet:		
Evaporative	6,886	8,120
Superheater	1,584	2,059
Total	8,470	10,179
Grate area, square feet	90	108·2
Wheelbase, ft-in	90 0	91 3
Weight, tons (2240 lb):		
On all coupled wheels	340·4	324·1
Total locomotive	380·8	377·0
Tank capacity, gallons (U.S.)	10,000	13,000
Coal, tons (2000 lb)	16	12
Maximum tractive effort, lb (compound)	160,000	166,300
Factor of adhesion	4·77	4·37

Erie Railroad.—Dimensions apply to the first locomotive built, 1914.
Virginian Railroad.—Locomotive weights estimated.

Cross-Channel Ship "Koningin Wilhelmina"

MOTOR VESSEL FOR HARWICH—HOOK OF HOLLAND DAY SERVICE

By G. W. TRIPP, O.B.E., F.C.G.I., M.I.C.E.

THE Zeeland Steamship Company has a history extending over more than eighty years, the Dutch Government having been anxious to maintain its own mail services to England, and also to reduce the time between the two capitals, the result being that in 1875 with the support of the Government this steamer company was formed. With the co-operation of the London, Chatham and Dover Railway and the Dutch State Railways a service was planned between Flushing and Queenborough, the latter situated where the river Medway flows into the estuary of the Thames. The service did not have a very auspicious start for Queenborough pier was not ready and Sheerness had to be used as a temporary British terminal, and then a number of adverse circumstances led to the suspension of the service for about six months, but after this a regular service that was destined to be well known settled down, and some of the finest cross-channel paddle steamers were built for the company.

Perhaps the most notable were three large steamers that came into service in 1887, "Deutschland," "Nederland" (Fig. 1), and "Engeland" (Fig. 2), all built by the Fairfield Shipbuilding and Engineering Company, the Zeeland Company's first steel vessels, and also the fastest, for they had a speed on trials of nearly 20 knots. They inaugurated a day service, the night service still being maintained by older craft. Their principal dimensions were: length 287ft; breadth 35·4ft; depth 16·6ft; tonnage 1660 gross. They were driven by two-cylinder engines having cylinder diameters of 60in and 104in with a stroke of 84in.

Nine years later a further three paddle steamers, from the same builder's yard, were added to the fleet, and these were among the finest cross-channel paddle steamers. Their names were "Koningin Wilhelmina," "Koningin Regentes," and "Prins Hendrik." These had the following principal dimensions: length 320ft; breadth 35·8ft; depth 16ft; tonnage 1947 gross. They were driven by three-cylinder triple-expansion engines having cylinders of 51in, 75in and 112in diameter respectively, with a stroke of 78in.

In 1909 a revolutionary change took place, for an order was given to the same shipbuilding company for three twin-screw vessels for the night service. These ships were named "Prinses Juliana," "Orange Nassau," and the first "Mecklenburg" (Fig. 3), and these had a length of 350ft, a breadth of 42·7ft, and a depth of 16·4ft, their tonnage being 2885 gross. They were driven by two sets of triple-expansion engines, having cylinders of a diameter of 28in, 43½in, 49in, and 49in respectively, with a stroke of 33in, giving a nominal horsepower of 1130.

Queenborough pier had not been altogether satisfactory for it had experienced two disastrous fires, resulting in the sailings having to be diverted temporarily to other ports, while the shallow water and surrounding sandbanks were not ideal for the new screw-propelled vessels, and the night service was accordingly diverted to Folkestone, the day service remaining at Queenborough. The first world war took a heavy toll of the Zeeland fleet for "Koningin Wilhelmina," "Koningin Regentes," "Prinses Juliana" and "Mecklenburg" were all casualties, while "Nederland" and "Engeland" had already gone to shipbreakers. On the cessation of hostilities it became necessary for new tonnage to join the fleet. Two new steamers were built in 1920, which bore the names of two that had been lost "Prinses Juliana" and "Mecklenburg" (Fig. 4). At this time most cross-channel steamers were being turbine driven, but it was decided that these two should be generally similar to the existing "Orange Nassau," and though they were built in Holland it is understood that the builders had the loan of the Fairfield designs.

In 1927 the service was transferred to Harwich, and in 1939 a radical change was made in that two diesel-engined motor ships "Prinses Beatrix" (Fig. 5) and "Koningin Emma" left the yard of the de Scheide Shipbuilding and Engineering Company, of Flushing, these being placed on the day service between the Hook of Holland and Harwich (Parkeston Quay). These were considerably larger than their predecessors, their principal dimensions being: length 359·6ft; breadth 47·2ft; depth 24·8ft; tonnage 4353 gross. They are driven by two-stroke cycle single-acting engines whose cylinders have a diameter of 22 13/16 in, and a stroke of 33 1/8 in, giving a speed on trials of 23·9 knots, their service speed being 21·5 knots. They are commodious vessels with greatly improved passenger accommodation, and having a garage for twenty-five cars. Although essentially day boats each has fifty-two passenger cabins. As they only came into service in the early summer of 1939, before they had properly settled down

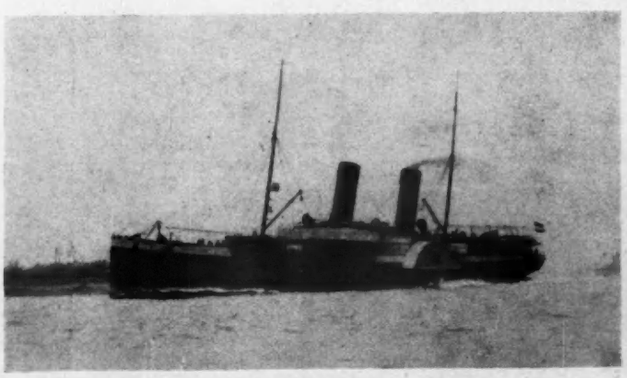


Fig. 1—P.S. "Nederland" (1887) leaving Queenborough

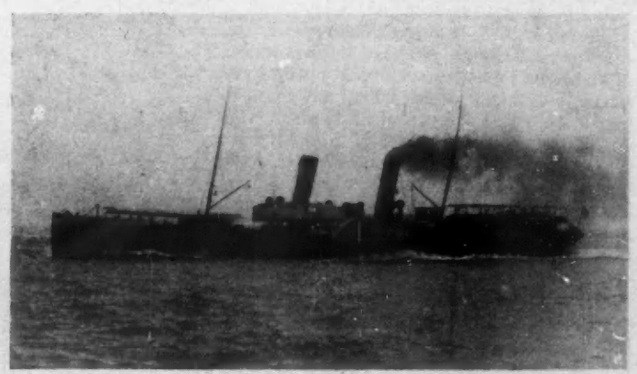


Fig. 2—P.S. "Engeland" (1887) crossing North Sea

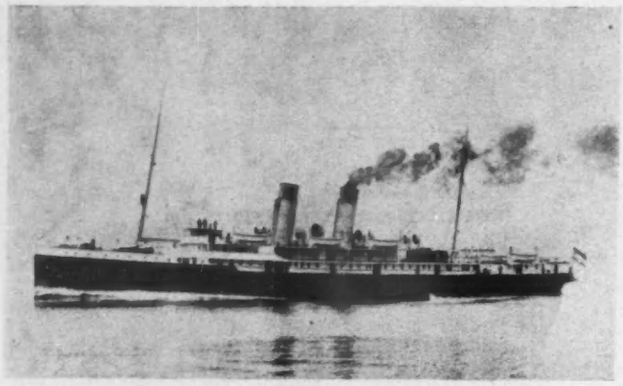


Fig. 3—The first S.S. "Mecklenburg" (1909)

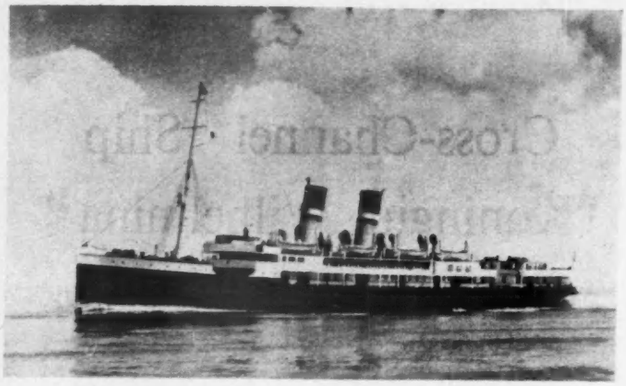


Fig. 4—The second S.S. "Mecklenburg" (1922) now being replaced

to their legitimate work the second world war broke out and sailings had to be suspended. Fortunately, both of them survived their exciting and varied war experiences, and after return to their owners they were thoroughly overhauled and fitted out. From 1948 they have maintained the day service, the steamer "Mecklenburg" acting as relief.

The last-mentioned vessel being over thirty-five years old, the directors felt that the time had arrived for her replacement, and on August 14, 1958, the keel was laid of a twin-screw motor ship, the builders on this occasion being the "De Merwede" shipyards at Hardinxueld-Giessendam. The superstructure is entirely of light metal alloy and has been manufactured by the "De Schelde" shipyards at Flushing. On May 30, 1959, H.M. Queen Juliana launched the new vessel named "Koningin Wilhelmina." As will be seen from the illustration (Fig. 6) this vessel has a very unusual appearance having a single mast and a streamlined funnel situated aft to enable the maximum space to be devoted to passengers in the most comfortable part of the vessel, a unique layout for cross-channel passenger vessels, although it had been adopted for the passenger liner "Southern Cross," and for many years on tankers, and a few cargo ships. The vessel has been built to comply with Lloyd's specification for class +100A1 for service between the south and east coasts of the United Kingdom to the Firth of Forth and the Netherlands, as well as for European cruising. Her principal dimensions are: length overall 393ft 10in, between perpendiculars 361ft; width 53ft 4in; depth to embarkation deck 31ft 2in; draught 16ft; tonnage 6228 gross, and 2727 net. She has accommodation for 1600 passengers in two classes.

The vessel is propelled by two twelve-cylinder supercharged two-stroke diesel M.A.N. direct reversible diesel engines, each cylinder having a bore of 57cm and a stroke of 80cm, giving a horsepower of 7800 at 225 r.p.m. These engines drive three-bladed manganese bronze propellers having a diameter of 3m 60cm, and imparting to the vessel a speed of 23½ knots. The auxiliary machinery consists of three M.A.N. four-stroke seven-cylinder engines, each having a bore of 33cm and stroke of 45cm. These are direct coupled to generators working at 440V 60 c/s supplied by the Dutch firm of Heemaf. There are two boilers each capable of supplying 3 tons of steam per hour at 90 lb per square inch pressure. The engine-room, generator room and boiler house are all spacious and well ventilated and are all provided with the ancillary equipment to be found on the modern cross-channel vessel. A number of new features are to be found in this ship, which is the largest to be employed on sailings between Britain and the Continent. Owing to the difficulties incident to berthing, both at the Hook of Holland and at Harwich, for the first time in a Zeeland Company's ship a Voith-Schneider propeller has been fitted in the bow below the water line, this being driven by a 400 h.p. electric motor. The vessel is also equipped with Denny-Brown stabilisers calculated to reduce rolling from 28 deg. to about 2 deg. All the superstructure above the boat deck is constructed of aluminium, as also is the funnel, with a view to stability. Every effort has been made to reduce to a minimum vibration, which has proved from the point of view of the passenger to be a drawback to the motor ship. For this purpose, tanks, walls, and decks have been covered with a noise-reducing layer, whilst the wooden panellings have been mounted on rubber spring fittings. All doors are closed magnetically on a method developed by Messrs. Keller-Sona. For fire prevention a full-automatic sprinkler system has been installed; openings in the fireproof partitions which divide the accommodation into various departments are closed by mechanical fireproof doors. For the engine-rooms, garages, and cargo holds, smoke detectors and CO_2 installations have been provided. Life saving equipment consists of eight lifeboats, constructed of polyester resin, each with a

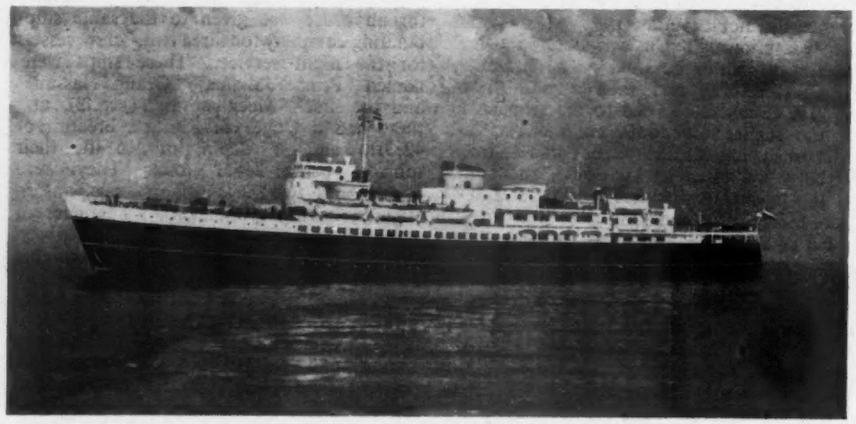


Fig. 5—M.V. "Prinses Beatrix" (1939)

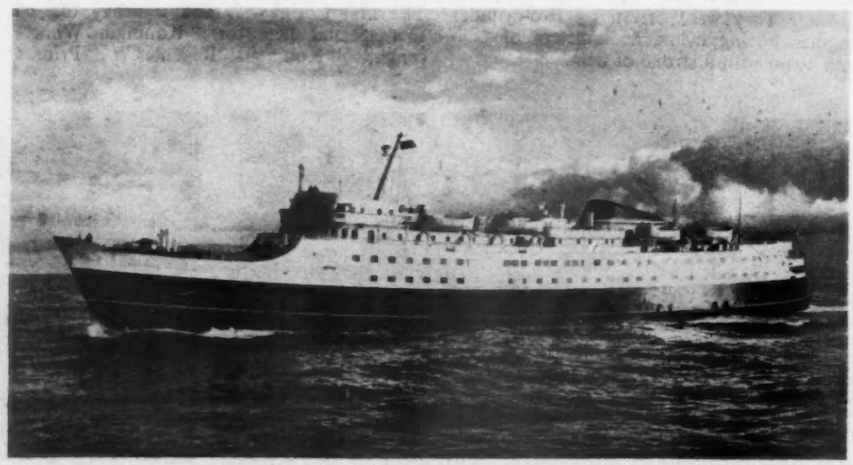


Fig. 6—"Koningin Wilhelmina" (1960)

capacity of sixty persons, and also seventy aluminium rafts to take twenty persons each. The following nautical instruments have been supplied : gyro compasses, Decca Navigator, echo sounding apparatus, two radars, radio telegraphy and telephony and v.h.f. telephony. In the engine-room is found an electric - hydraulic steering gear with two pump units, and when both of these pumps are in action the rudder can be completely turned in twenty seconds ; connection of the steering gear with the wheel house is by servomotor and double telemotor connections. On the saloon deck forward there are two horizontal capstans with chain wheels for the anchor gear, and on the embarkation deck aft is a warping engine with two drumheads.

Fore and aft there are garaging facilities for forty-five cars, and there is space for 200 tons of cargo, some being stowed loose and some in containers ; loading and discharging of cars and cargo is facilitated by all holds being provided with hydraulically-operated steel hatches which speedily give access for dealing with cars and cargo. The galley and pantries are situated amidships, being connected by three lifts, and in these all fittings, &c., are of stainless steel. The troublesome problem of hand baggage has been solved by providing large storage compartments adjacent to the embarkation and landing doors.

The vessel has five decks in addition to the bridge deck, on which will be found the only open deck, which can accommodate a large number of passengers, and is provided with benches and deck chairs. There is good accommodation for the master, and a room is provided for the use of the British pilot. Immediately under the bridge is a spacious observation lounge affording an uninterrupted view ahead, and on the deck below, known as the saloon deck, is a large and well-equipped dining saloon for first-class passengers, and aft a cafeteria extending the width of the vessel for second-class passengers. There is also a comfortably furnished lounge and bar. On the embarkation deck ample provision has been made for passengers' luggage; there is a large circulating area, a saloon for second-class passengers with a cold buffet, and an extra counter for the sale of liquid refreshments. The lower decks are mainly for staff, crew, stewards and those attached to the engine-room, &c.

Among the special provisions made for passengers it might be mentioned that there are ten de luxe cabins, provided with sleeping sofas and convertible beds, some with private toilets and showers, and they also have a ship-to-shore telephone in each cabin. There is also a twelve-seater conference room which is furnished with telephone and typewriter ; this can also be used as a small private dining saloon. Twenty-nine two-berth cabins with wash stands are available for first-class passengers. A rest room is available, but it can only be used for sleeping when the ship is in port. There is a dormitory for passengers who dread a sea voyage, and in this are two-berth separate compartments. Accommodation both for passengers and crew is of a high standard.

As it is realised that some of the facilities afforded for the first time on the new ship will be henceforth expected, it is intended to install them in "Koningin Emma" and "Prinses Beatrix" as soon as they can be released for the purpose.

On Wednesday, February 3, a demonstration cruise took place on which it was very noticeable that the problem of vibration had been tackled to such an extent that it is far less than on the other vessels of the company, and it was also noticed that the vessel was very steady in a moderate sea-way, and that she should satisfy the needs of the most exacting passenger. Incidentally she is probably the largest cross-channel vessel that could be used on the service.

While many will regret the passing of "Mecklenburg," the last twin-screw passenger vessel driven by reciprocating engines, it will be readily agreed that her replacement is a most interesting craft. The "Koningin Wilhelmina's" maiden voyage took place on Sunday, February 7, when she left the Hook of Holland to take up regular sailings.

Operation of Gas-Turbine Ship "Goodwood"

THE following is a joint report, made by the shipowners and engine builders, on the first eight months of operation of the free piston gas turbine machinery installed in the "Goodwood." This is a 3500-ton deadweight dry cargo ship owned by France Fenwick and Co., Ltd., which was converted from oil-burning, reciprocating, steam machinery to free piston/gas turbine propulsion in the early part of 1959 by Smith's Dock Company, Ltd., Middlesbrough, and described in THE ENGINEER of April 10, 1959.

A total running time of just over 3000 hours for the turbine and each of the two gasifiers has now been logged, during which the vessel has encountered severe North Atlantic weather, forced ice in the Kara Sea, manœuvred up and down the canals to Vilvorde on two occasions without damage, and encountered severe freezing on her last voyage to Archangel.

At all times the engineers have had complete confidence in the machinery. The master and pilots, as soon as they had become acquainted with the characteristics of the machinery, had no undue difficulty in manœuvring the ship.

It is difficult to comment on the financial results of the first eight months' operations, except to say that if the conversion had not been done, the vessel would have undoubtedly been laid up, whereas in fact she has contributed towards her depreciation. It was not expected that any real profit margin would be obtained until the machinery was burning residual fuel. In this connection the last voyage, Grimsby-Archangel-Vilvorde, was carried out using residual fuel of viscosity 1000 seconds Redwood I at 100 deg. Fah.

Engine-room reliability and performance have been most satisfactory and on no occasion has the ship been without power or delayed in sailing due to engine trouble.

FUEL AND LUBRICANT

Apart from a short run on a 2000 seconds Redwood I fuel on trials, all gasifier operation during the first 2500 hours was on marine diesel fuel, as the ship was under charter from the end of May until October, for which this fuel was specified. Since then, "Goodwood" has operated satisfactorily for over 500 hours on a 1000 seconds fuel (Redwood I).

Satisfactory lubrication of the gasifier engine has been achieved so far with Mobilgard Marine 593 oil, at an oil flow rate of three pints per hour per gasifier.

The designed performance of 0·42 lb per shaft horsepower-hour at 1700 s.h.p. has been realised. The last voyage of some 200 hours' duration was carried out on 1000 seconds fuel at 1700 s.h.p., at an average specific fuel consumption for the whole voyage of 0·418 lb per shaft horsepower-hour.

GASIFIERS

The gasifiers, built by Smith's Dock Company, Ltd., under licence from Alan Muntz and Co., Ltd., are of S.E.M.E. GS–34 design.

During the first six months of operation on marine diesel fuel a gasifier stopped while at sea on three occasions ; the other gasifier continued running.

These stops were due to :

	Time out of service
Manœuvring piston fracture	30 hours
Fuel pump return spring failure...	16 hours
Fuel pump accumulator plunger seizure	3 hours

The manœuvring rod failure was the most serious, and no attempt was made to repair the gasifier until the ship was in port thirty hours later. Damage was found to be very slight, but later the piston synchronising linkage was removed, as the link bush had been elongated. The fuel pump return spring failure occurred shortly after the manœuvring piston failure. Consequently, although the trouble was rapidly diagnosed, it was decided to check the linkage gear at the same time, prolonging the period for which the gasifier was out of service. A second pump return spring failure within the last 500 hours was diagnosed and made good in under an hour.

In addition to the above stops, a gasifier was shut down while in open sea on ten occasions to investigate and repair the following faults :

	Time out of service
Remove insecure internal heat shield	3 hours
Repair leaking cushion release valve	12 hours
H.p. fuel line joint leaks (6 occasions)	12 hours (total)
Renew damaged suction valve joint washer ...	1 hour
Replace cracked water inlet pipe on headplates	8 hours

Some trouble was experienced during the first voyage from water leaks from the valve pockets in the compressor headplates, but these were replaced by headplates of a modified design after this voyage and have given no trouble since.

Inspection of the moving parts and interior of the engine after 2500 hours has shown both gasifiers to be very clean and free from deposits.

Detailed information on operation during the last two months is not yet available beyond the fact that one gasifier stopped on two occasions due to a fuel pump return spring failure and an accumulator plunger seizure. The gasifier was out of service for under one hour in each case.

Measurements taken after 2500 hours of operation indicate that the maximum rate of wear on the engine cylinder diameter is of the order of 0·001in per 1000 hours for the scavenge liner and under 0·002in per 1000 hours for the exhaust liner. Maximum radial wear per 1000 hours for the top three piston rings, ignoring wear at the ring horns, is under 0·005in for both top rings, under 0·001in (scavenge) and 0·002in (exhaust) for the second ring, and about 0·004in for both third rings. All rings have been in continuous use, representing over 3000 hours of operation for each ring to date.

TURBINE AND TRANSMISSION

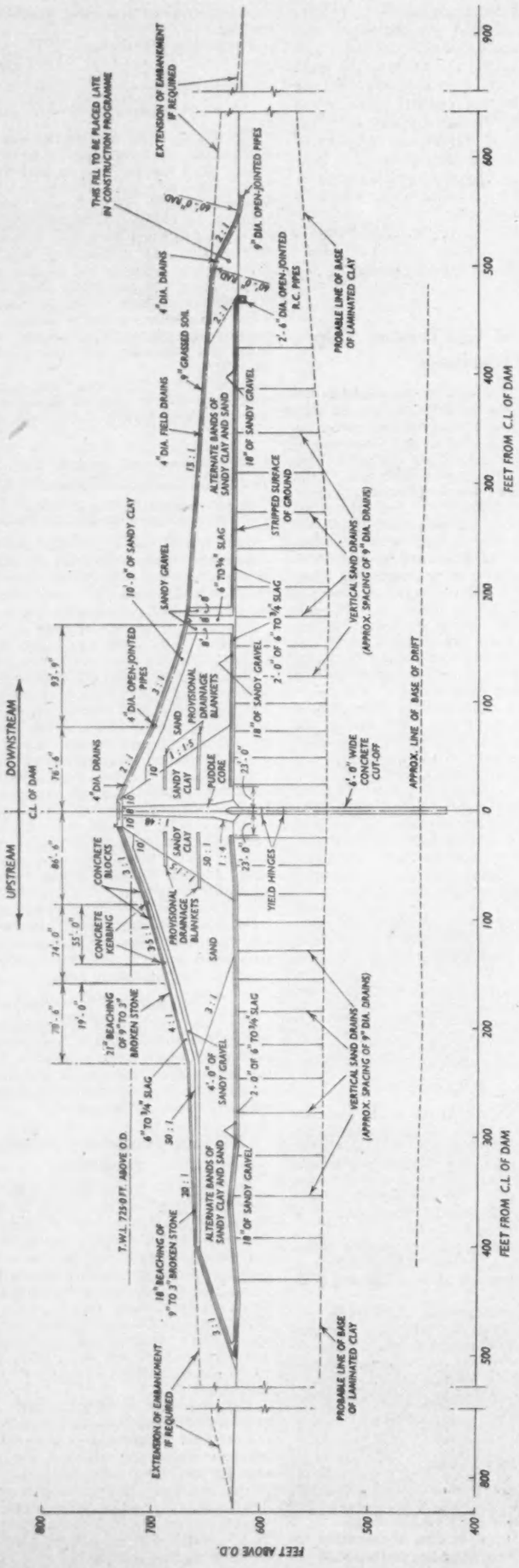
The Alsthom turbine has operated satisfactorily. No maintenance or inspection has been carried out, and it is not proposed to inspect this unit until twelve months' operation has been completed. The Renk double-reduction gearbox also performed satisfactorily.

Surface Temperature Indicating Materials

THE range of surface temperature indicating materials made in the United States by the Markal Company is now available from A. Levermore and Co., Ltd., Kenley Park House, Hayes Lane, Kenley, Surrey. These "Thermomelt" materials are made in the form of sticks, pellets and liquids, and when they are applied to a surface they melt as the specified temperature is attained. They are made to cover sixty temperature calibrations from 113 deg. to 2000 deg. Fah., and are claimed to be accurate within ±1 deg. of the stated temperature.

The stick form of "Thermomelt" is used to apply a dull chalky mark on a surface, and when the required temperature is attained this mark becomes liquid and glossy. The pellets are used for indicating temperatures in inaccessible places and melt at the required temperature. The liquid forms of the material can be painted on smooth, glossy and intricately shaped surfaces where normal temperature indicating instruments cannot be fitted.

Typical Section of the Derwent Dam for Water Supply in Sunderland, South Shields and County Durham


UPSTREAM
DOWNSTREAM
C.L. OF DAM
THIS FILL TO BE PLACED LATE IN CONSTRUCTION PROGRAMME
EXTENSION OF EMBANKMENT IF REQUIRED
6" DIA. OPEN-JOINTED PIPES
2'-6" DIA. OPEN-JOINTED R.C. PIPES
PROBABLE LINE OF BASE OF LAMINATED CLAY
4" DIA. DRAINS
9" GRASSED SOIL
4" DIA. FIELD DRAINS
ALTERNATE BANDS OF SANDY CLAY AND SAND
18" OF SANDY GRAVEL
STRIPPED SURFACE OF GROUND
10'-0" OF SANDY CLAY
SANDY GRAVEL
6" TO ¾" SLAG
VERTICAL SAND DRAINS (APPROX. SPACING OF 9" DIA. DRAINS)
4" DIA. OPEN-JOINTED PIPES
PROVISIONAL DRAINAGE BLANKETS
SAND
2'-0" OF 6" TO ¾" SLAG
SANDY CLAY
PUDDLE CORE
6'-0" WIDE CONCRETE CUT-OFF
APPROX. LINE OF BASE OF DRIFT
CONCRETE BLOCKS
CONCRETE KERBING
YIELD HINGES
21" BEACHING OF 9" TO 3" BROKEN STONE
4'-0" OF SANDY GRAVEL
T.W.L. 725·0 FT. ABOVE O.D.
18" BEACHING OF 9" TO 3" BROKEN STONE
EXTENSION OF EMBANKMENT IF REQUIRED
FEET FROM C.L. OF DAM
FEET ABOVE O.D.

Derwent Reservoir

THE recent award of the main contract for the construction of the Derwent dam draws attention to the exceptionally interesting engineering features inherent both in design and construction of this structure. The River Derwent is a southern tributary of the Tyne, and forms the boundary between Durham and Northumberland in the area where the scheme is to be built. The joint sponsors of the scheme, which is for regional water supply, are the Sunderland and South Shields Water Company and the Durham County Water Board. Design of the dam is the responsibility of Mr. A. G. McLellan, M.I.C.E., the general manager of the former of the two undertakings just named, which is responsible for the construction of the scheme. The contractor for the dam is John Mowlem and Co., Ltd., and the contract price is £5,281,611. Work is scheduled to commence on April 1 and the contract time is six years. The reservoir will be 3½ miles long and up to a mile wide and will contain 11,000 million gallons. The top water area will be 1000 acres.

The dam will be 3000ft long, of 119ft maximum height and will contain 2,600,000 cubic yards of fill. It will have a puddle clay core above ground and a concrete cut-off below ground. The cut-off will consist of a mass-concrete-filled trench, 6ft wide, extending to a maximum depth below ground of 200ft. It will pass through about 50ft of varying sandy and clayey materials, 50ft of laminated clay, 90ft of artesian-water-bearing sand and finally penetrate into sandstone and shale. The rock beneath the concrete cut-off will be cement grouted. The laminated clay will require to be drained and it will accordingly be penetrated by a system of 4000 vertical sand drains to release the pore pressures arising from the construction of the embankment.

The accompanying typical section of the dam is at about the centre of the valley, where its height is a maximum. The base of the laminated clay and the base of the drift are indicated, and the flat slopes and great spread of the dam are immediately apparent. A decision on whether or not to extend the dam to the limits shown by the dotted lines will be taken at a later stage, after an appreciation has been made from pore pressure and settlement measurements. Note the very comprehensive drainage arrangements. The four provisional drainage blankets comprise a 12in layer of 6in to ¾in slag sandwiched between 12in layers of sandy gravel. The field drains are to be at 50ft centres; the open-jointed pipes are to be in slag-filled trenches, and the 4in drains above them will be at 150ft centres.

The complete Derwent scheme, of which this is the first and largest contract, will, in addition, include the construction of the following works: 4 miles of roads to replace two roads which will be submerged by the reservoir; intakes on streams in an adjacent valley, together with 2 miles of 48in diameter catchwater pipeline; 2¾ miles of 60in diameter unfiltered water aqueduct from the reservoir to the treatment works; and treatment works to deal with 32 m.g.d.

The gross yield of the reservoir is estimated at 27½ m.g.d. from its direct catchment, increased to 32 m.g.d. by the diversion. There will be about 6 m.g.d. of compensation water, and hence an ultimate net yield of 26 m.g.d., which will be shared equally by the Company and the Board.

The treatment works will consist of sedimentation tanks, rapid gravity filters, chemical storage and dosing equipment, filtered water storage, washwater recovery plant and sludge disposal works. The main building, in addition to housing the chemical stores, plant, automatic controls, laboratory, workshop and administrative offices, will contain a pump room to pump the Board's share of the water into a high level service reservoir. The Company's share of the water will gravitate to the area of supply. With the exception of the Board's pumping installation, the cost of the foregoing works will be shared equally between the Board and the Company.

In addition to these "joint" works, the Company and the Board will each construct pipelines and service reservoirs to convey their respective shares of the water into their existing systems of supply. The Company's works, in this respect, will consist of 21 miles of 39in to 33in diameter pipelines and four service reservoirs of 6, 1½, 1½ and ½ m.g. capacity respectively. The Board's works will comprise the laying of 13 miles of 42in to 33in diameter mains and the construction of a service reservoir of 8 m.g. capacity. The total estimated cost of all the works in the scheme will be of the order of £10,000,000. All the works, including the reservoir area and road diversions, will receive landscape treatment.

First B.R. Type 3 Locomotive

WHEN the first phase of the Southern Region, British Railways, Kent Coast electrification scheme was opened last June, diesel-electric motive power for services in the area which could not be electrically operated was provided by fifteen type 2 locomotives loaned by the London Midland Region. The Southern Region has now received the first of the ninety-eight diesel locomotives required for its scheme of eliminating steam traction in Kent and Sussex. These are classified as type 3 and are the first of this power classification to go into service on British Railways. The locomotives have been built by the Birmingham Railway Carriage and Wagon Company, Ltd., with power equipment by Sulzer Bros. (London), Ltd., and Crompton Parkinson, Ltd. Basically the design follows that of the 1160 h.p. type 2 locomotives by the same builders (see our December 5, 1958, issue), and has the same B_0–B_0 wheel arrangement, but by making provision for electric train heating, the steam boiler has been eliminated and for the same locomotive weight of 75 tons it has been possible to fit an eight-cylinder engine giving 1550 h.p. Maximum tractive effort is 45,000 lb and the continuous T.E. rating 26,000 lb at 17·5 m.p.h.

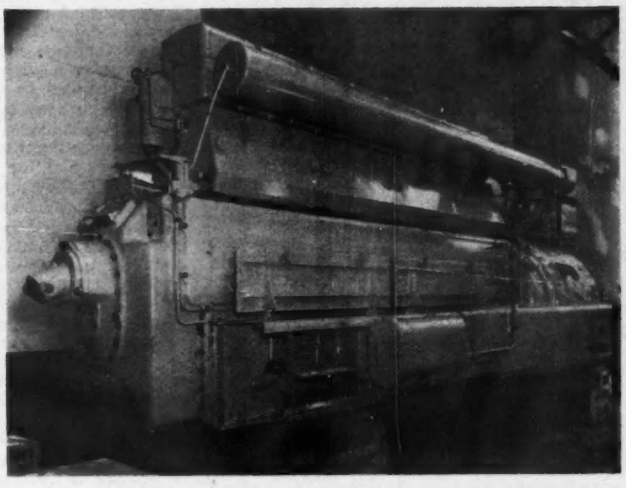


Fig. 1—Engine-generator set comprising 8LDA28 engine and combined traction, auxiliary and train-heating generator

The Sulzer 8LDA28 pressure-charged, eight-cylinder in-line diesel engine (Fig. 1) has not been used previously on British Railways, or elsewhere, in revenue-earning service. It is of 280mm bore and 360mm stroke. The continuous rated output of 1550 b.h.p. is at 750 r.p.m. and 85 deg. Fah. and the one-hour 10 per cent overload test-bed rating is 1705 b.h.p. at 750 r.p.m. The brake mean effective pressure at the rated output is 151 lb per square inch and the guaranteed specific fuel consumption is 0·381 lb per brake horsepower hour. At 50 per cent load and 530 r.p.m., the guaranteed consumption is 0·368 lb per brake horsepower hour. Maximum piston speed is 1770ft per minute. The radiator fan drive is by the Serck-Behr hydrostatic system instead of the electric drive in the type 2 locomotives.

Engine speed is continuously adjustable by the normal Sulzer regulator controlled by a self-lapping air valve in the master controller. Idling speed when train heating is not in use is 325 r.p.m., but this is increased automatically to 550 r.p.m. when power is being taken from the heating generator. The diesel engines are being manufactured by Vickers Armstrongs (Engineers), Ltd., at Barrow-in-Furness, and a large number of the Sulzer turbo-blowers will be built by the de Havilland Engine Company, Ltd., at Leavesden, Herts.

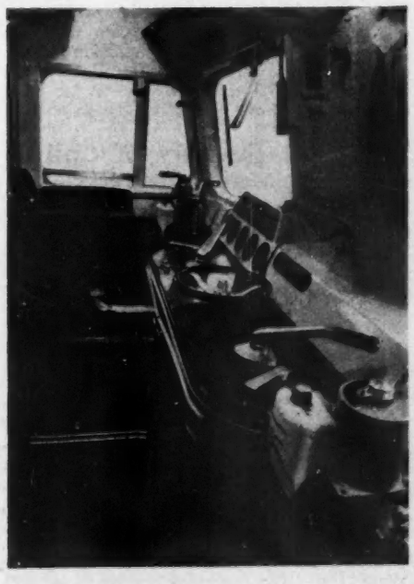


Fig. 2—Duplicated driving controls in locomotive cab

The Crompton Parkinson main generator is rated at 1012kW, 575V, 1760A, at 750 r.p.m. Traction, train heating and auxiliary generator armatures are mounted on a common cast steel rotor in the same frame. The four traction motors are forced ventilated machines rated continuously at 305 h.p., 440A, 580V, and drive through resilient gear wheels with a ratio of 62—17. Five steps of field-weakening are introduced automatically by a cam group driven by a pilot motor under the control of the load regulator and a current relay.

The 235kW train heating generator is a separately-excited machine situated at the engine end of the main generator frame and is designed to give approximately 800V d.c. at any speed from 550 to 750 r.p.m. A d.c. system was chosen primarily for ease of regulation. By taking the train heating supply from the main engine, benefit is obtained from the fact that while the diesel engine is set to give a nominal 1550 b.h.p., corresponding to an inlet air temperature of 85 deg. Fah., for any temperature below this figure the engine output will rise by about 15 h.p. for every 10 deg. Fah. decrease. In winter, therefore, a considerable reserve of power can be diverted usefully to train heating. With 150kW of train heating in operation at normal inlet air temperature at the engine, the locomotive will haul a 400-ton passenger train on the level at 68 m.p.h., and this speed is increased to 75 m.p.h. in the same conditions without train heating. Maximum permitted speed is 80 m.p.h.

Coach heating systems may have either a single-pole feed and running rail return or a double-pole supply, in which case there are positive and negative jumpers. Also in this latter system, which is to become a British Railways standard, is incorporated an interlocking device such that if any jumper in any part of the train is disconnected while the heating supply is switched on, the feed to the heating contactor on the locomotive is automatically interrupted. Either system can be selected by the driver, according to whether a train is composed of B.R. standard rolling stock (two-pole system) or Continental and certain Southern Region stock (U.I.C. system). When the locomotives are operated in multiple, only the trailing unit supplies heating current and it is for this reason that the heating generator output has been made as high as 235kW.

Fig. 2 shows the duplicated driving controls in one of the locomotive cabs—a desk layout with two complete driving positions being provided instead of the driver's and assistant driver's positions in other two-cab locomotives on British Railways. The locomotive is fitted with the Oerlikon form of automatic air brake equipment manufactured by Davies and Metcalfe, Ltd. For locomotive braking the only control is by a self-lapping diaphragm-operated valve, but for working with fitted stock having either air or vacuum brakes, control is by an Oerlikon FV3 automatic air brake valve operating through a distributor valve to give either air or vacuum train brake control. This air brake control enables the locomotive to haul Continental train ferry stock or "dead" multiple-unit electric stock fitted with air braking. In contrast to other diesel-electric locomotives on British Railways, the braking is "air dominated" instead of "vacuum-dominated"; that is to say, the train brakes, whether air or vacuum, are controlled through the locomotive air-brake system. When hauling air-braked stock, therefore, there is no need to run the exhausters to provide braking control. For vacuum braking of rolling stock, the locomotive is equipped with two Reavell exhausters driven by flange-mounted Crompton Parkinson motors.

Experimental Underground Tunnel

LONDON TRANSPORT has announced the placing of two contracts for experimental tunnelling in the Finsbury Park area. A twin tunnel, approximately a mile in length, is being constructed to enable experience to be gained in the use of new methods of tunnel lining and construction for tube railways. It is pointed out by London Transport that no complete new tube across London has been built for about fifty years, so the experimental lengths of tunnel will provide important information on the suitability of various constructional methods for use in any future tube railway.

The tunnels are being constructed on the alignment of the proposed Victoria Line at Finsbury Park. If the Government authorises the building of the Victoria Line, this section of tunnelling would be incorporated in it. The contracts are as follows: Kinnear Moodie and Co., Ltd.—construction of experimental length of concrete-lined tunnel, Finsbury Park to Manor House, at a value of approximately £191,000; Edmund Nuttall Sons and Co. (London), Ltd.—construction of experimental length of cast iron lined tunnel, Netherton Road (Tottenham) to Manor House at a value of approximately £209,000.

Two new methods of constructing the tunnel linings, to replace the conventional method of erecting bolted cast iron segments, are being considered, and one is being tried out in each of these contracts. The concrete-lined tunnel will consist of rings each comprising fourteen precast concrete "segments," with a key segment at the crown. The segments will be forced apart against the circumambient clay by jacks, and then the key segment inserted. The internal diameter of this tunnel will be 12ft 6in. The experimental cast iron lined tunnel will have flexible joints. The cast iron segments will be without flanges or bolts, with six segments in a ring. Once again, the segments will be jacked apart and then cast steel wedges will be inserted. The internal diameter of this tunnel will be 12ft 8in. Tunnelling shields adapted for each of these two methods of construction will be used.

SHORTER REPORTS

Institution of Civil Engineers

THE Institution of Civil Engineers announces that a memorial service for the late Mr. A. C. Hartley, president of the Institution and a past-president of the Institution of Mechanical Engineers, is to be held at St. Margaret's, Westminster, at 2.30 p.m. on Tuesday next, February 16.

The Institution has also announced that arising from the sudden death of the president, Mr. A. C. Hartley, a special general meeting of corporate members will be held at the Institution on February 23 at 5.25 p.m. The following resolution will be placed before the meeting: "That Sir Herbert John Baptista Manzoni, C.B.E., vice-president, nominated by the council in accordance with Section XII of the by-laws, be elected president of the Institution for the remainder of the year 1959–60 in succession to the late Mr. A. C. Hartley."

Institution of Electrical Engineers

THE council of the Institution of Electrical Engineers has elected to Honorary Membership of the Institution Colonel B. H. Leeson, C.B.E., T.D., in recognition of his extensive contributions to the application of electrical science and engineering in the manufacture of electrical plant and equipment, to the development of co-operative effort within the electrical industry and to the training of electrical engineers, and of the services he has rendered to the Institution over nearly half a century. Colonel Leeson recently retired as director of BEAMA. In 1952 he was president of the I.E.E.

Normally only one Honorary Member is elected each year but once in every three-year period the council is empowered to elect an additional Honorary Member. In this category it has elected Dr. Richard L. Hearn, M.A.Sc., D.Eng., for his notable contributions in the development of electricity generation and supply, particularly in Canada, and for the part he has played in international co-operation in this field. Dr. Hearn has held a succession of appointments with the Hydro-Electric Power Commission of Ontario and served as its chairman from 1955 to 1956. His name is associated with pioneering work in large-scale steam generation in Canada and in exploiting power generation from Niagara Falls. He is now a director of Atomic Energy of Canada, Ltd.

The council has also made the thirty-eighth award of the Faraday Medal to Sir George Thomson, D.Sc., F.R.S., in recognition of his outstanding contribution to the advancement of electrical science, of the leadership in research which he has given to others in this field, and of his inspiring services to education in science and technology.

Grantham By-Pass

IT has been announced by Mr. Ernest Marples, Minister of Transport, that work will start shortly on a 10-mile dual carriageway road to by-pass Grantham in Lincolnshire, on the A.1 road. This is a further instalment of the plan to modernise the Great North Road between London and Newcastle, which was commented upon in our annual review articles in THE ENGINEER of January 15 last.

The first part of the scheme lies between the River Witham bridge at Colsterworth and Little Ponton cross-roads, south of Grantham. The present 22ft carriageway will be widened to 24ft, a new 24ft carriageway will be built separated from the first carriageway by a 24ft central reservation, and hard shoulders will be provided. Work on this part of the scheme will involve excavation of more than 500,000 cubic yards.

Construction of the Grantham and Great Gonerby by-pass forms the second part of the scheme. The by-pass will have dual 24ft carriageways, a 15ft central reservation and 12ft 6in wide verges which will include hard shoulders. The by-pass will go over or under all intersecting roads, apart from one T-junction near the roundabout at the northern end. Access to the by-pass from the Leicester-Grantham (A.607) and Nottingham-Grantham (A.52) roads will be by slip roads, and there will be a flyover junction with the existing A.1 at the southern end. Six road bridges of reinforced concrete and two railway bridges will be built. Excavation for the by-pass will amount to 1,500,000 cubic yards.

The present A.1 route goes through one of the main shopping streets of Grantham, where four junctions are controlled by traffic light signals. The work will be supervised by Mr. R. R. Dalton, M.Inst.Mun.E., county surveyor to Lincoln (parts of Kesteven) County Council, on behalf of the Minister. The contract for the work, which is due for completion by early 1962, has been let to Robert McGregor and Sons, Ltd., of Manchester, whose tender was £1,856,009.

The Ministry of Transport's plan to modernise the Great North Road is estimated to cost £50,000,000. Of the 220 miles of A.1 between London and Newcastle, 71 miles have already been converted to dual carriageway and with the commencement of the Grantham by-pass, work will be in progress on the improvement of a further 63 miles.

Thames Pollution and the L.C.C.'s Responsibilities

AT last Tuesday's meeting of the London County Council, one of the matters on the agenda paper was a report of the Council's rivers and drainage committee in which the course of a legal action taken against the Council, and concerning pollution in the River Thames, was explained. The following account is abstracted more or less unaltered, from the Council's agenda paper.

"The hearing of an action brought against the Middlesex County Council and the L.C.C. by D. Badcock, Ltd., Greenwich, began in the Chancery Division of the High Court before the Hon. Mr. Justice Roxburgh on November 20, 1959. The plaintiff sought an injunction perpetually restraining both Councils from causing or permitting any effluent to flow or pass from their outfall works into the River Thames so as to cause a public nuisance upon the river highway to the injury of the plaintiff company exercising its public right of way upon such highway, damages and costs. The Council was alleged to have discharged into the river from the northern outfall works, Beckton, Essex, and the southern outfall works, Erith, an effluent consisting of sewage matter insufficiently treated and purified. It was further alleged *inter alia* that, because of the activities of both councils, the waters of the river, at least from Waterloo Bridge downwards, were at all times in a grossly polluted and putrefying state, that in the reaches of the river below Woolwich the waters were totally or almost totally devoid of dissolved oxygen, and that foul and putrefying solid matter was deposited from the river waters on to the bed of the river where it formed banks of filthy mud. This mud, together with the condition of the waters, was alleged to have corroded and destroyed the steel bottoms of the company's barges, which rested at low tide on the bed of the river, and made it necessary for the bottoms to be replaced many years before replacement should have become necessary.

"The trial was expected to last several weeks and, to ensure that the Council was adequately represented throughout, four counsel were instructed. Evidence was given by two witnesses for the plaintiff who were cross-examined by Mr. Gerald Gardiner, Q.C., and Mr. R. W. Goff, Q.C., on behalf of the Council and by Sir Milner Holland, C.B.E., Q.C., on behalf of the Middlesex County Council. During the cross-examination on December 2, 1959, it became apparent that the plaintiff had attempted, in the company's further and better particulars of the statement of claim, to extend the cause of the action pleaded in the statement of claim so as to include partial replacement or repairs as distinct from the replacement of the whole of the bottoms of the barges. Counsel for the plaintiff applied to amend the statement and the application was opposed by both defendants. The judge granted leave for certain amendments to be made, subject to specific records as to the movements and the maintenance and repairs of the plaintiff's barges being forthcoming from the plaintiff. When the parties reassembled on December 3, 1959, counsel for the plaintiff informed the Court that, having given careful consideration to what had occurred on the previous day and to the state of the case, his clients had instructed him that the company would submit to judgment for both defendants with costs. The state of the case referred to above was in no small measure due to the material given by the Council's professional officers to counsel, for the cross-examination of the plaintiff's witnesses. Judgment was accordingly entered for the Middlesex County Council and the Council with costs which are expected to amount to several thousand pounds. The trial lasted eight days.

"This action was probably one of the most formidable with which any local authority has been faced in the history of the courts and, in addition to the question of the liability for damage, was a test of the Council's statutory powers. Preparation for the trial, in co-operation with the Middlesex County Council, proceeded for over a year and necessitated the tracing and perusing of books and records, some of which were over a hundred years old, and the preparation of a long list of those which were considered relevant, for the use of counsel and the court; inspections of some of the barges by the Council's scientific and engineering staffs and by independent experts; experiments on barge plates in the Council's laboratories; the tabulation of the results of the experiments and their consideration by independent experts in chemical metallurgy; the preparation by the Council's scientific adviser of tables of the results of examinations of 250,000 samples of water taken from the River Thames; and the comparison of the chemical content of mud taken from the Thames and from other rivers in counties as far apart as Devon and Essex, and from London ponds."

Tabular Summary of Civil Engineering Contracts

OUR attention has been drawn to an error in the new edition of the *Tabular Summary of Civil Engineering Contracts* which was published as a supplement to our issue of January 22. On page 77, the contractor for the bridge over the Molonglo River at Canberra (the consultants are Messrs. G. Maunsell and Partners) is not Clark Pty., Ltd., the firm's correct title being M. R. Hornibrook, McKenzie Clark, Pty., Ltd.

One large scheme which is omitted from the *Tabular Summary* is that being undertaken by the Middlesex County Council for West Middlesex Main Drainage. This scheme involves extensions to Mogden and Perry Oaks Works, and is under the direction of Mr. C. B. Townend, M.I.C.E. The main contractors are W. and C. French, Ltd., William Moss and Sons, Ltd., George Reeves and Sons, Ltd., and Harland and Wolff, Ltd. The estimated cost is £1,400,000, and the dates of starting and completion are, respectively, 1955 and 1961.

Machine Tool Industry Inquiry

THE BRITISH ASSOCIATION OF MACHINE TOOL MERCHANTS has sent a letter, dated February 5, to the Rt. Hon. Reginald Maudling, President of the Board of Trade. We print the letter below.

"This Association has repeatedly, and as recently as June last, submitted to your predecessors a claim for representation on the Machine Tool Advisory Council but, so far, has been denied the opportunity to appoint members from our council who, by reason of the Association's Constitution, membership and activities ; particularly in the field of distribution and 'usage' of machine tools both in the home and export markets ; are in a pre-eminent position to advise yourself through the M.T.A.C. on matters concerning the welfare and expansion of the U.K. machine tool industry.

"My council have more recently noted with concern the Press references to Professor Melman's report and those also of the Department of Scientific and Industrial Research and the National Production Advisory Council of Industry.

"Although it is fully appreciated that the technical information contained in these reports must of necessity for the time being be restricted in publication, more especially abroad, my council is unable to find any valid reason why certain of its well informed members should not be appointed to serve on the recently formed sub-committee under the chairmanship of Sir Steuart Mitchell which was announced in the House of Commons on the 26th ultimo by Mr. John Rodgers, Parliamentary Secretary to the Board of Trade.

"Having regard to the urgency of this matter, my council would much appreciate your early response to this communication."

Air Conditioning Installation at Printing Works

A WASHER plant operating on a fixed dewpoint basis, with heating and cooling to the sprays, together with tempering heater batteries, has recently been designed and installed by Carter Thermal Engineering, Ltd., at the new factory of Kalamazoo, Ltd., printers, of Birmingham. This plant controls conditions to 54 per cent R.H. ± 2 per cent and 68 deg. Fah. ± 1 deg. Fah. in a single-storey "Northlight" building of approximately 50,000 square feet. The plant was designed with special emphasis on efficiency and operating costs ; it incorporates variable speed drives to two "Aerofoil" centrifugal fans, and a special air control economy system. As a result the overall running costs of this plant are approximately 35 per cent lower than those of a comparable conventional dewpoint control plant.

In the plant as designed air is drawn through a double spray bank washer where it is automatically adjusted to the dewpoint setting by heating or cooling to the sprays. Direct control of the washer tank water temperature is not employed, thus giving rapid response to changing conditions of the entering air. On leaving the washer the air passes via main heater batteries, which automatically compensate for changing external conditions, and is delivered by two centrifugal fans into the main delivery trunking. Branch ducts are taken from this trunking into each factory bay and tempering heater batteries are installed in each branch duct to ensure precise control of shop conditions.

The main trunks and branch duct heater batteries are all contained within a special service duct, which is placed centrally across the factory area and also acts as return air trunking, the return air being drawn in through special adjustable grilles situated along the sides and base of the duct.

Conditioned air is delivered at high level into the working area by suitably placed "Airmaster" diffusers, and the air velocities throughout the system have been kept low to provide silent, draught-free distribution. The total volume of air delivered is varied by adjusting the fan speeds to suit load conditions, a maximum of 130,000 cubic feet per minute being available.

Water cooling is catered for by 150 h.p. compressor refrigeration plant with automatic capacity control. This cooling plant is brought into action automatically as required, and the capacity adjusted to suit the load. Two pumps in parallel are employed to feed the sprays and scrubbers, these also serve the cooling water system, thus eliminating the need for separate pumps, and contributing to the running economy.

The whole plant is fully automatic and is controlled from wet and dry bulb thermostats only, these operating via electronic panels. This use of thermostatic control reduces everything to its simplest form and provides for trouble-free running.

The provision of full air conditioning ensures the control of factory conditions to within the recommended range and should eliminate paper feeding trouble due to curling, creasing and size variations, &c., thus giving higher operating speeds with more consistent results.

[Reply Card No. E2692]

Naval Architects Spring Meeting

THE Spring Meeting of the Royal Institution of Naval Architects will be held in the Weir Lecture Hall, 10, Upper Belgrave Street, London, S.W.1, March 22 to 24. On Tuesday, March 22, the annual general meeting will be held in the morning, followed by a paper entitled "A Marine Engineering Review, Past, Present and Future," by T. W. F. Brown, D.Sc. The annual dinner will be held at Grosvenor House on the evening of the opening day. Two papers will be presented on Wednesday morning, "The Development of the Aircraft Carrier," by J. H. B. Chapman, R.C.N.C. and "Development of Anchors" by H. L. Dove and G. S. Ferris, R.C.N.C., and two more in the afternoon, namely, "Standard Model Technique at Admiralty Experiment Works, Haslar," by R. N. Newton, R.C.N.C., and "An Oceanographic Research Submarine of Aluminium for Operation to 15,000ft," by E. Wenk, Jr., R. C. de Hart, Professor P. Mandel and Captain R. Kissinger, U.S.N. Five papers will be read on Thursday, March 24 : "Methane Transportation by Sea," by E. C. B. Corlett, M.A., Ph.D., and J. F. Leathard, B.Sc., Ph.D., and "Transverse Strength of Single Hulled Ships," by I. M. Yuille, B.Sc., Ph.D., and L. B. Wilson, in the morning and in the afternoon session, H. M. Barkla, M.A., B.Sc., will read his paper, "The Behaviour of the Sailing Yacht," and T. Tanner, A.C.G.I., will present two papers, "Full-Scale Tank Tests of An International 10 Square Metre Class Canoe," and "The Geometry of Sailing to Windward."

Protection of Industrial Property

IT has just been announced that the twenty-fourth Congress of the International Association for the Protection of Industrial Property is to be held in London from Saturday, May 28, to Saturday, June 4, this year. The Congress will be held under the presidency of Sir John Hanbury-Williams. This association is concerned with patents and trade marks and similar rights. Back in 1883, a convention was concluded which lays down principles to be applied by all member states in their own legislation in order to secure that a minimum and reciprocal treatment in obtaining protection for patents and trade marks should be given to the nationals of all countries who are members of the Union. At present time, forty-seven countries are members. From time to time the Convention has been revised, the last occasion being at Lisbon in 1958. The full agenda for the London meeting has not yet been settled but the organising committee believes that there are many aspects of the Convention which, despite all efforts at Lisbon, still need attention and that there is a considerable amount of new work to be done towards obtaining harmonisation of national laws and practice in industrial property. This is thought to be a topic of particular importance, "having regard to the current trend towards economic integration on the international plane, of which examples are to be seen in recent developments in the Benelux countries, the Scandinavian countries, the European Economic Community, and the proposed Free Trade Area, and in the various international organisations directed to the economic development of particular industries." Over 600 members from thirty-five countries are expected to attend the Congress.

Commonwealth Technical Training Week

IT is announced that H.R.H. The Duke of Edinburgh, in his capacity as president of the City and Guilds of London Institute, has approved the decision that in the United Kingdom the date of the Commonwealth Technical Training Week will be from Monday, May 29, 1961, to Sunday, June 4, inclusive. It is hoped that it will be possible to hold the "Week" in other parts of the Commonwealth, and that, as far as possible, the same dates will be chosen. It will be recalled that, at a meeting at Buckingham Palace last May, it was agreed that a Commonwealth Technical Training Week should be held throughout the Commonwealth in 1961. The object of the week is to stimulate awareness of the responsibility of the community towards young people entering employment, and to stress the importance of schemes of induction and training.

The City and Guilds of London Institute undertook the central administrative responsibility for the week. In this country the direct organisation will be in the hands of local authorities. The Institute has therefore written to all county, city, borough, and urban and rural district councils in England and Wales, and to local authorities in Scotland and Northern Ireland, informing them of the date selected. Local authorities are also being asked to consider whether they wish to take part in the week, and, if so, to decide among themselves the most suitable areas for the purpose and the best way of organising the week so as to secure the most effective co-operation of the many interests concerned.

Data Acquisition and Monitoring

DETAILS have been announced by de Havilland Propellors, Ltd., Hatfield Aerodrome, Hatfield, Herts, of equipment developed for gathering and monitoring information on the operation of plant and machinery. The system, known as "Data Acquisition and Monitoring Equipment" (D.A.M.E.) will scan incoming electrical signals from different parts of the plant, and provide data in typewritten, magnetic tape, punched tape or punched card form for analysis and computation. Alternatively the operation of a plant or system may be monitored continuously, deviations from a stipulated performance being displayed digitally and warning indications being given, or an emergency programme initiated, in the event of a channel being outside limits. A third facility is to initiate, check and control a routine sequence of operations. Remote control and display equipment may be connected to D.A.M.E. over any distance by means of ordinary telephone lines.

[Reply Card No. 2696]

Multi-Bank Hydraulic Control Valves

A HYDRAULIC valve made by Joseph Young and Sons, Ltd., Kay Street, Bolton, is designed for assembly into a multi-bank control system for mechanical handling and other equipment. It is stated that any number of these valves assembled into a bank can be used either individually or simultaneously without load drop when controlling cylinders working at lower than mains operational pressure. This facility for group or individual operation has been made possible by the incorporation of a special check valve in the pressure line between the valve spools in each valve body. The check valve and associated porting are of sufficient capacity to avoid the generation of heat under operational conditions.

The valves are made in a number of sizes with capacities from 15 to 45 gallons per minute and for operating pressures up to 2000 lb per square inch.

[Reply Card No. E2697]

SHORTER REPORTS *(Continued)*

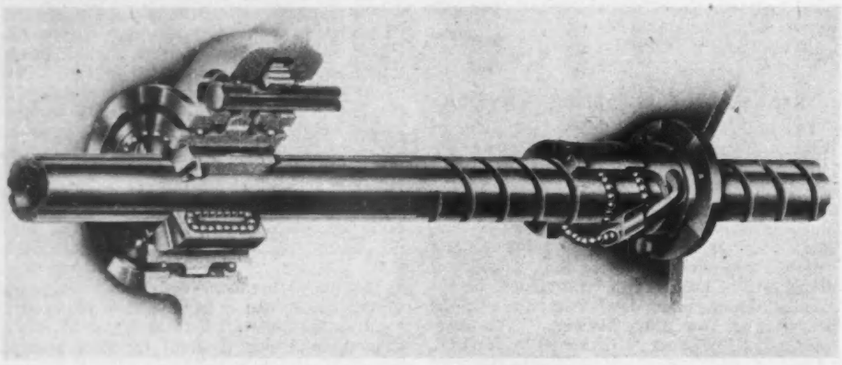
Recirculating Ball Screws and Splines

A RANGE of recirculating ball screws for use with electrical, hydraulic, mechanical or pneumatic mechanisms, is now made by Bristol Siddeley Engines, Ltd., Filton, Bristol. Screws for these recirculating ball units have been made as small as 2in long by $\frac{1}{16}$in pitch diameter and the firm can now grind 6in pitch diameter screws of any required length. Such screws, it is stated, can have a lead accuracy of 0·0005in per foot, and in converting thrust to torque, or torque to thrust, the units have a minimum efficiency of 90 per cent. Recirculating ball screws have been supplied for working efficiently for long periods without lubrication at temperatures between −52 deg. and 400 deg. Cent. A typical screw made by the firm can be seen on the right-hand end of the shaft in the sectional photograph we reproduce.

A more recent development is the ball bearing spline in which teeth and keyway are eliminated and rolling balls in surface contact perform all the functions of normal splines. The male member of the ball spline has two, three or more axial raceways equally spaced around its circumference. The female member forms the outer race of the ball bearing assembly and has internal raceways. The balls in the co-operating raceways remain in independent closed circuits, the female member being fitted in each raceway with ball return guides to interrupt the path of the balls, deflect them from the raceway, and guide them through a passage in the body of the female member and then return them to the other end of the raceway.

Every splined member must be able to endure torsional or bending loads, or both, at least to some extent, while permitting linear motion with practically no resistance. With conventional splines relatively small loads cause resistance to linear movement. Ball splines, on the other hand, will transmit, withstand or restrain exceptionally high torque loads whilst still permitting almost frictionless linear movement. They will also endure bending loads which would be excessive for normal splines and still allow easy linear motion. The sectioned photograph shows an interesting application combining a recirculating ball screw and a ball spline. As the shaft is rotated by the gearing in the left-hand assembly the fixed nut of the ball screw on the right imparts axial travel of the shaft as a result of its rotation. During this shaft traverse movement friction is reduced to a minimum by the ball spline fitted between the shaft and its surrounding collar.

[Reply Card No. E2701]



An application in which both a ball screw and a ball spline are used

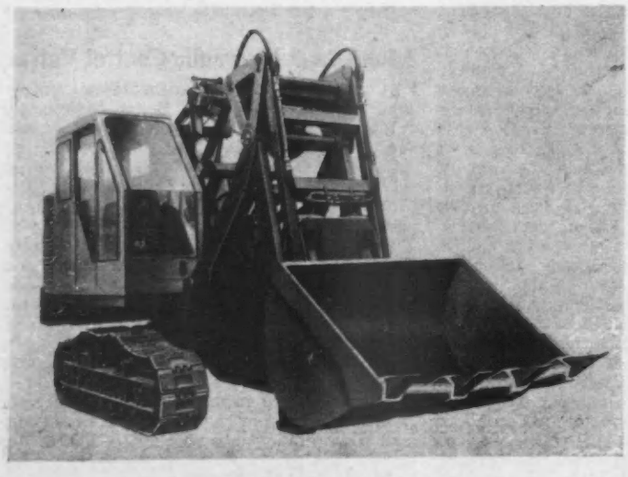
Heavy Duty Shovel Loader

WE illustrate a heavy duty machine which has been developed by Blaw Knox, Ltd., 94, Brompton Road, London, S.W.3, for excavating and loading materials in quarries, sand and gravel pits, stockyards, &c. It can be fitted with a 2 cubic yard bucket for general purpose work, a 1½ cubic yard bucket for rock handling or larger capacity buckets when used with lighter materials such as coal or coke. This "Hydrascoop" machine has a turntable mounting on a crawler base and its rotating frame slews over a full circle on four wide-faced rollers, three double stabilising rollers being fitted to prevent tilting. When operating on the level the bucket has a "clean-up" radius of 20ft, and the machine will extract material from any angle of slope as well as excavate to a depth of 2ft below ground level. It has a minimum discharge height of 9ft 10in, and the slewing speed of the bucket is about 5 r.p.m.

The bucket is pivotally mounted on a frame on an arm which comprises a system of parallel links designed to maintain bucket level during lifting to prevent spillage. This arm assembly is raised and lowered through a hoisting line and for the actual digging operation is actuated by hydraulic rams. Twin double-acting 4in diameter hydraulic rams between the upper and lower arm sections are designed to exert a thrust of 38,000 lb at the bucket teeth for the digging operation. The bucket is then turned for the "break-out" of its load by a second pair of hydraulic rams which exert a breaking effort of 21,300 lb. A massive crowding frame on the machine is designed to take the break-out forces when digging.

The machine is driven by an oil engine developing 676 h.p. at 1380 r.p.m., and a pump supplying pressure fluid to the hydraulic system is driven from the engine power take-off. If required the machine can be converted for operation with a face shovel, drag shovel skimmer, dragline, pile-driver or as a crane.

[Reply Card No. E2702]



Shovel loader with 2 cubic yard bucket

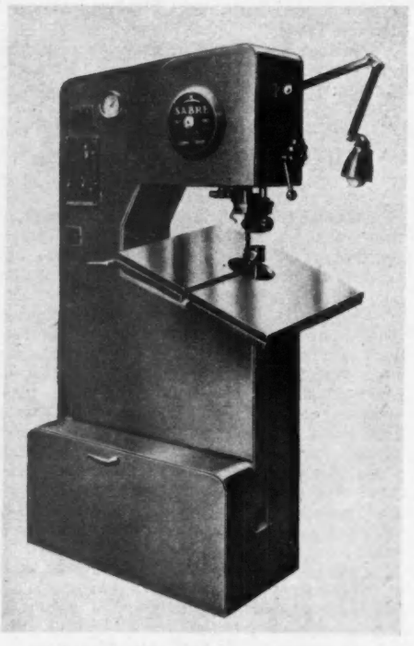
Bandsawing Machine

A BANDSAWING and filing machine recently added to the equipment made by the Startrite Machine Tool Company, Ltd., Gads Hill, Gillingham, Kent, has a 20in deep throat, a depth of 8in under the guides and a 23in square table. It takes a 130in long blade and ten blade speeds from 65ft to 3700ft per minute or from 47ft to 2700ft per minute are available.

The new machine can be seen in our illustration. An automatic butt welder for blades up to $\frac{3}{4}$in wide is situated in a convenient position on the main column and a blade cropper, grinder and gauge are included in the standard equipment. A compression spring saw trimming device is linked with a dial indicator showing the correct tension for different blade widths. Bonded rubber tyres are fitted on the steel wheels carrying the band, the drive from the 1½ h.p. motor in the base being transmitted through a gearbox and vee belts.

Self-indexing guides are fitted on the machine and the lower guide can be raised above table surface level to afford more positive control of the blade when machining profiles and awkward shapes. To facilitate adjustment, the upper guide post is counterbalanced. The table can be tilted up to 45 deg. to the right, 10 deg. to the left, and 5 deg. forwards or backwards, and it is provided with a tee-slot in the front face for the support of various attachments. These attachments include a circle cutting unit, a rip fence, a rack and pinion feed unit, and heavy-duty guides.

[Reply Card No. E2703]



Bandsawing and filing machine

Ships' Radiotelephone Service

MEDIUM-FREQUENCY channels for public radiotelephone calls from long-voyage ships at ranges up to about 250 miles are being made available at certain Post Office coast radio stations. As a result of transferring this medium-range traffic from the h.f. long-distance service, via Rugby and Criggion, by which it was handled previously, the cost of calls will be reduced from 36s. for three minutes to 10s. 6d. The first of four coast stations to be equipped is Lands End radio, where the service was introduced last week, following the introduction of a v.h.f. radiotelephone service (range 40–50 miles) in January. Niton radio will be equipped similarly for m.f. medium-range telephony in April, and North Foreland radio and Anglesey radio will follow. At first the service is being confined to calls between ships of United Kingdom register and telephone subscribers in the United Kingdom and Republic of Ireland. It is hoped, however, that later it will be possible to extend the facilities to foreign ships and to accept European and overseas calls. In addition to its use by long-voyage ships, the service is also available to cross-Channel and similar small vessels which have provided public telephone service on the 1605–3950 kc/s band.

Initially the equipment at Lands End radio is working normal duplex with amplitude modulation, but the transmitters are also suitable for single sideband operation, thus approximately halving the frequency bandwidth per channel, or for independent sideband, which provides two simultaneous channels with one carrier. The system thus makes full provision for meeting the growing demand on marine telephony services with economy in the frequencies occupied.

The Lands End transmitters are the "Redifon" G.423B, of the G.420 series manufactured by Redifon, Ltd., Broomhill Road, London, S.W.18 (see our December 11, 1959, issue, page 771). Each of the three transmitters installed is set up on a specific frequency, but is equipped for operation on one other frequency, so that should any channel fail, the remaining equipment may be used to the best advantage. Power output is 1·5kW p.e.p. The fixed-tune, crystal-controlled receivers are the "Redifon" R.151, and are also equipped to provide a reserve for each other. Each channel has its own voice-operated terminal equipment for duplex working; speech privacy facilities can be switched in as desired. "Redifon" RA.10 adaptors are being provided so that these receivers may be used for S.S.B. or I.S.B. reception. Similar transmitting and receiving equipment by the same maker is being supplied for Niton, North Foreland and Anglesey.

All the radio and audio-frequency equipment is installed in an unattended outbuilding. A control panel at each telephony operating console in the main station enables the operator to control the channels and provides all the switching, monitoring and call-timing facilities for handling calls extended into the inland telephone network. A new transmitting aerial has been installed with a broadband characteristic over approximately the range of coast station radiotelephony frequencies in the medium frequency band. The outputs of the three transmitters are fed via 75 ohm coaxial cables to a series of combining filters, which also serve to isolate the transmitters from each other. The three combined transmissions are then fed over a single 75 ohm coaxial cable to a matching unit at the base of the aerial.

[Reply Card No. E2711]

Aids to Electronics Instruction

THE need for demonstrating the behaviour of electronic components and circuits, to reinforce text book instruction, is being met by a growing number of devices and publications. We illustrate such an aid from the Special Products Department of A.E.I. Radio and Electronic Components Division, Associated Electrical Industries (Woolwich), Ltd., 155, Charing Cross Road, London, W.C.2. This belongs to a series of eleven chassis designed in collaboration with the Northampton Polytechnic to form the basis of laboratory experiments in radio and electronic theory at audio frequencies. Each unit is supplied with instruction sheets covering a number of experiments and the underlying theory, meeting the needs of students both at elementary and more advanced levels.

The unit shown is a resistance-capacity-coupled amplifier, and Fig. 1 illustrates the principle common to the major devices in this series of printing the theoretical circuit on the front panel and mounting the actual terminals and switches in the positions where their symbols would normally appear in the diagram. In this amplifier the switching enables the effects of alternative coupling capacitors and of feed-back to be shown, and enables a tuned anode load peaking at 2 kc/s to be brought into circuit. The chassis has a "Perspex" base through which, as seen in Fig. 2, the actual components represented in the circuit diagram may be viewed and the run of the wiring can be followed. The valve is a double-triode corresponding to VIA and VIB in the circuit diagram. Other chassis in the series are designed to teach the basic connections of international octal, B7G and B9A valves, and the operation of R.C. coupled and tuned anode oscillators, low-pass and high-pass networks and a power output stage. [Reply Card No. E2712A]

A similar purpose is served by a series of leaflets entitled "Demonstrations and Experiments in Electronics" which are published by Mullard, Ltd., Educational Service, Mullard House, Torrington Place, London, W.C.1, although here the user builds up his own equipment from brief instructions and suggestions. A simple "breadboard" layout may be adopted, but a box construction with "Perspex" panel is recommended. A typical leaflet in this series describes a demonstration unit for comparison of the grid control characteristics of gas-filled and vacuum valves, with theoretical circuit, notes on power supplies and meters required, and a description of an experiment. The series therefore serves both as a basis for practical constructional work and as lecture notes for the instructor.

[Reply Card No. E2712B]

Site Caravans

THE prototype of a caravan to provide personnel accommodation at remote working sites, such as at oil fields in the desert or undeveloped areas in the east, has been built by Frederick Braby and Co., Ltd., to specifications prepared by Auto Diesels, Ltd., Uxbridge, Middlesex, a member firm of the Braby group. This prototype caravan provides sleeping and living accommodation for eight native workers and specifications have been prepared for vehicles for housing two or four staff members and for married quarters. The caravan, which is skid-mounted, is 30ft long, 10ft wide and 10ft high, and it weighs about 6½ tons. Production models of the caravans will, we understand, be of sectional design to facilitate transport.

The body frame of the caravan is of closed steel channel sections bolted together and clad with 18 gauge galvanised sheets on the outside and 22 gauge sheets on the inside. Effective insulation is provided by 3in thick expanded polystyrene in the sides and ceiling cavities and under the floor. The roof, of cavity construction, has an air space between an outer sheathing of aluminium and the insulated metal ceiling. Four double-tier bunks installed in this particular vehicle are of sheet metal construction with wire mesh mattress supports carried on tubular steel frames. These bunks are situated at one end of the vehicle and at their ends are large double lockers for the personal possessions of the occupants. At the opposite end of the caravan there are two shower cubicles, a wash-basin and two toilets. Hot water is provided by a copper cylinder containing an immersion heater and cold water is distributed by copper pipework to the necessary points.

For lighting purposes a socket on the outside of the caravan can be connected to a three-phase and neutral supply. Two air conditioning units, on opposite walls, each have a designed rate of heat extraction of 13,100 B.Th.U. per hour cooling and provide 420 cubic feet per minute of air for ventilation purposes. Warm air can be supplied by 2kW heaters built into these units when needed.

[Reply Card No. E2713]

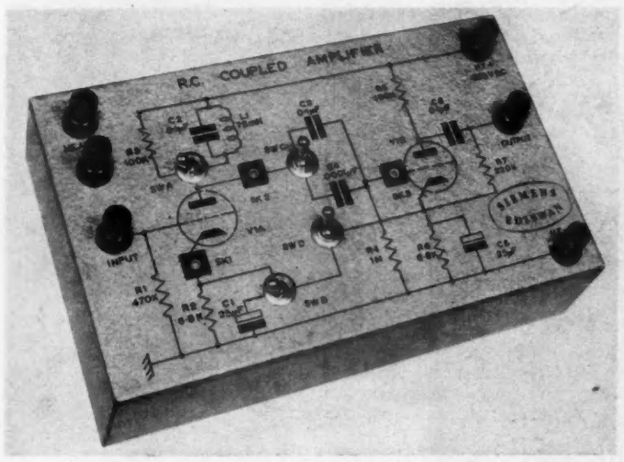


Fig. 1—Resistance-capacity coupled amplifier, with "mimic diagram" presentation of schematic circuit and switching

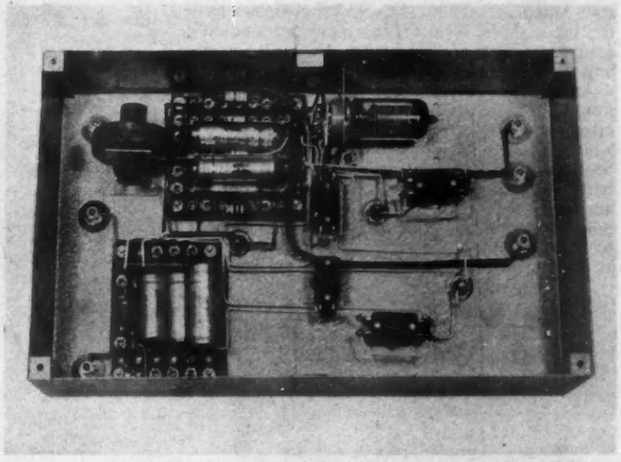


Fig. 2—Underside of R.C. amplifier, showing component layout visible through "Perspex" base

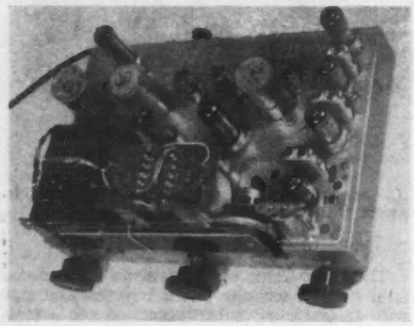
SHORTER REPORTS *(Continued)*

Stereophonic Broadcasting System

In our January 29 issue, page 190, we noted that a new system for stereophonic broadcasting, also compatible for monophonic reception on unmodified v.h.f. sets, had been put forward for assessment to the European Broadcasting Union by Mullard, Ltd., Mullard House, Torrington Place, London, W.C.1. Last week we attended a demonstration of the system at Mullard House. To meet Post Office requirements, the power was limited to a few microwatts on 90 Mc/s, and the transmitting and receiving aerials were separated only by a matter of inches. The principal demonstrations were conducted by Mr. G. D. Browne, of the Mullard Research Laboratories, who has developed the system.

One of the fundamental requirements has been that the system should occupy only the same bandwidth as a monophonic service. The method adopted is a multiplex transmission in which the two audio sources characteristic of stereophony modulate separate pulse trains. At this stage an identifying pulse is added to every pulse of one train, defined as the "A" train. The two trains, "A" and "B," of amplitude-modulated pulses are then combined in a complex signal in which the pulses of each train alternate, and this resultant is applied as the input signal to a normal frequency-modulated transmitter. The bandwidth is 15 kc/s and the switching frequency 32·5 kc/s.

At the receiver the signal is handled in the normal manner up to the output of the discriminator. It then passes to a decoding stage which switches the pulses alternately via independent audio stages to the left-hand and right-hand loudspeakers corresponding to the "A" and "B" microphones at the studio, the "A" pulses being recognised and correctly channelled by the identifying pulses mentioned above. In the accompanying illustration of an experimental receiver used at the demonstrations, the two switching valves of the decoding circuits and the two output amplifiers are seen in the centre of the chassis. The valves on the right are those of the normal f.m. receiver circuits.



Experimental f.m. receiver for stereophonic broadcasts by time multiplex. The switching valves and independent output valves for "right" and "left" loudspeaker channels are seen in the centre of the chassis

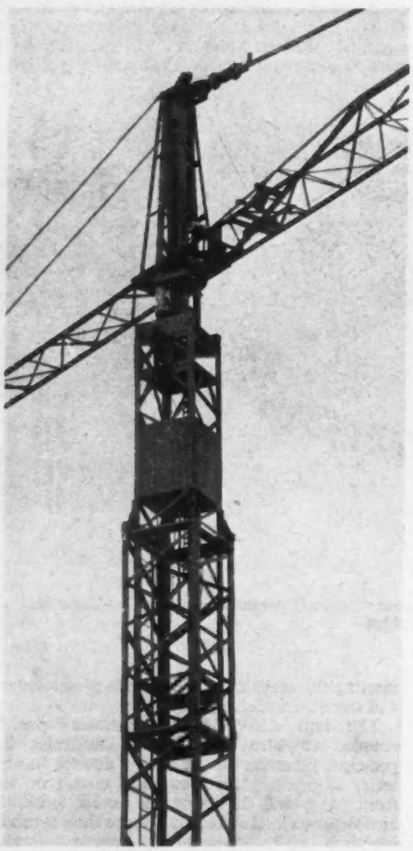
The transmitter bandwidth of the complex signal is such that stereophonic programmes can be received on an ordinary receiver and reproduced monophonically. Since the switching frequency is twice the highest audio-frequency, and other sidebands produced by the combination of pulse trains are outside the audio range, no difference from a normal broadcast transmission is detected. A receiver equipped for stereophonic reproduction by the Mullard system will receive monophonic programmes either on two loudspeakers, with the switching between them running "free" in the absence of synchronising pulses, or on one loudspeaker only by switching out the second channel. It is stated that the signal/noise ratio is improved by the latter method.

During the demonstrations simultaneous transmissions were made in English and French, and attention was drawn to the possibilities of the system in countries requiring bilingual announcements. We understand, however, that if separate programmes were transmitted simultaneously on one channel there would be risk of "cross-talk" unless somewhat more elaborate decoding circuits were used in the receiver than those contemplated at present. The aim so far has been to minimise the modifications required both at the transmitting and receiving ends.

[Reply Card No. E2721]

Self-Erecting Tower Crane

We are informed by George Cohen, Sons and Co., Ltd., Wood Lane, London, W.12, that a new and larger capacity model of the "Pingon" tower crane is being marketed by the firm in this country. This crane, the "P 18," has a maximum capacity of 40 cwt at 29ft radius and lifts up to 14 cwt at its full radius of 82ft. The jib length can be reduced to give a maximum working radius of 66ft or 43ft. In its rail-mounted form the crane has a maximum height of 109ft under the hook, and this height can be increased substantially if anchorage means are provided. The crane has a push-button remote control panel and is fitted with a two-speed hoist and slewing motors, its total power requirement being 20kVA.



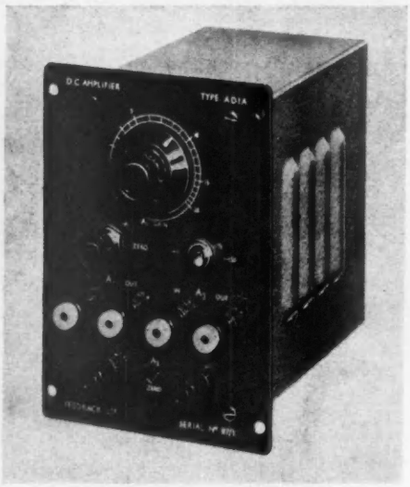
Tower crane jib and counter jib mounted on an inner mast which telescopes into the main mast

In this design of crane, as can be seen in the illustration, the jib and counter mast are carried on a short inner mast which is of slightly smaller section than the main mast inside which it rises. In a somewhat similar manner to a climbing crane, the top assembly can be raised within the main mast when the crane is being erected. The main mast is built up of sections, each of which initially has one side open to enable them to be positioned round the lower part of the extended inner mast by the crane's own hook. As each main section is placed in position the cross members of its open side are bolted in position and it is locked to the main mast structure. The inner mast is raised within the new top sections as they are erected until the required working height is reached.

[Reply Card No. E2722]

Variable Gain D.C. Amplifier

The d.c. amplifier unit illustrated is one of a range of devices made by Feedback, Ltd., 1, Broadway, Crowborough, Sussex, for use by research and design departments. Two amplifier circuits are incorporated. One amplifier has an operating range of d.c. to 100 kc/s (± 3 dB) with balanced input stage to reduce drift effects, and gain continuously variable from +1 to +20 by feedback adjustment. The other amplifier can be switched to give a gain of either −1 (d.c. to 100 kc/s) for phase reversal, or −150 (d.c. to 40 kc/s) for addition, integration, or function generation using external networks. Both amplifiers have high input impedance and low output impedance, with a maximum output of ±50V, ±2mA. The two amplifiers may be used independently or connected in series to give a maximum gain of −3000 for more precise function generation. The complete unit is contained in a case measuring 3¾in by 5¾in by 6¼in, attached to a rack-mounting control panel measuring 5in by 6¼in.



Amplifier unit containing two d.c. amplifiers with differing characteristics

The amplifier, known as the AD1A, is intended for experimental work on aspects of system frequency and transient response, and as a unit for analogue computer arrangements. In many such applications the main need is for an adaptable unit containing some built-in control facilities.

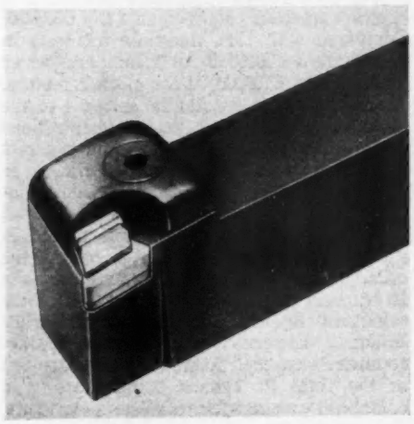
[Reply Card No. E2723]

Metallic Corrosion Congress

The First International Congress on Metallic Corrosion will be held in the Imperial College of Science and Technology in London from April 10 to April 15, 1961. The scientific programme is being organised by a committee under the chairmanship of Mr. L. Kenworthy, chairman of the Corrosion Group of the Society of Chemical Industry, and the congress will cover corrosion under the following headings: Corrosion Principals and Fundamentals; Papers Primarily Relating to Particular Metals; Papers Primarily Relating to Particular Environments; Papers Relating to Methods of Protection; General Papers; Economics and Design; Methods of Testing; and Education.

"Throw-Away" Tool Tips and Holders

DURING the past few years the use of "throw-away" carbide tips with a number of cutting edges has been steadily increasing, particularly for single point turning, where down times for tool changing can be appreciably reduced and need for special carbide tool lapping and grinding machines is largely avoided. A number of special holders have been developed for use with these throw-away tips and we have now received particulars of the "T-max" lathe tool holder introduced by the Sandvik Steel Works Company, Ltd., of Sweden. These holders are made

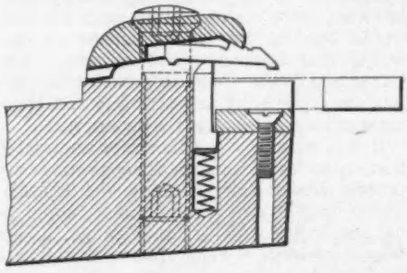


Holder with chip breaker clamped over throw-away carbide tip

in some seventy-eight types and sizes and for use with square and triangular tips. They are supplied in this country by Sandvik Swedish Steels, Ltd., Manor Lane, Halesowen, Birmingham.

Throw-away tips are made by this manufacturer in two finishes—one with only the top and bottom faces ground and the other ground on all faces. In each finish two thicknesses of tip are made and holders can be supplied for positive and negative rake, and for right- and left-hand machining. The wide selection of tips and holders available and a facility for introducing a chip breaker covers the requirements of a wide range of lathe operations.

A typical holder of "T-max" design is illustrated and the tip assembly and clamping



Throw-away tip clamping arrangement with chip breaker held up against clamp whilst tip is being changed

arrangement can clearly be seen in the drawing we reproduce. The holder has a hardened chrome vanadium steel body, in the recessed corner of which the "throw-away" tip seats on a renewable carbide shim-piece held in position by a small tubular pin. The tip clamping block is located in the holder by pins and, to simplify tool changing when a holder is mounted upside down, clamping screws are accessible from both the top and bottom of the holder.

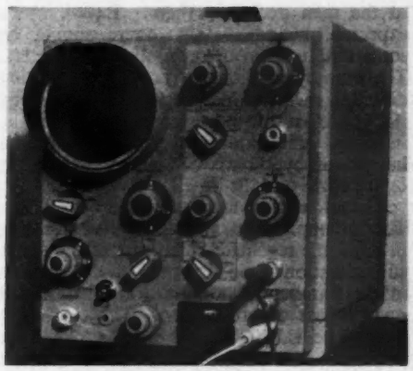
The problem of chip breaking with this design of tool has been solved by the use of a separate carbide piece which can be inserted between the throw-away tip and the clamp block, as shown in the drawing. Three slots are formed across the top surface of the chip breaker for engagement by the front lip of the clamp, and one of these slots can be selected to set the piece in accordance with the required chip breaking width. To avoid difficulties involved in handling small loose parts when changing or turning a tip in a holder to present a new cutting edge, a spring-loaded pin is fitted to hold the chip breaker up against the clamp as the clamping screw is loosened, as can be seen in our drawing. When the clamp is tightened after tip changes the chip breaker automatically registers in its previously selected notch in respect to the tip.

An analysis of the comparative costs using throw-away tips and conventional brazed tipped tools was made by the firm in the machining of rough 5in diameter, 35in long, hot rolled bars in a special purpose lathe. In each case similar feeds and cutting depths were used and the results showed the "T-max" tooling reduced machining costs by 14 per cent and increased production by 16 per cent.

[Reply Card No. E2731]

Portable Double-Beam Oscilloscope

RECOGNISING the growing use of oscilloscopes in surroundings far removed from their original laboratory environment, a new portable instrument has been introduced by the Solartron Electronic Group, Ltd., Thames Ditton, Surrey, which breaks away from the somewhat sombre styling often accepted as appropriate for these appliances. This is a double-beam instrument with a cathode ray tube having two electron guns, giving greater freedom from symmetrical distortions and brighter traces than in a single-gun tube with splitter plate. The use of the double-gun tube has also enabled the instrument



Portable double-beam oscilloscope with functionally-grouped controls and distinctive panel markings

to be made of a convenient size for portability, since tubes with splitter plates are generally larger than the 3½in diameter flat-face tube used in this instrument.

The oscilloscope has two vertical deflection amplifiers employing identical circuits, each channel having a bandwidth in excess of d.c. to 5 Mc/s (−3 dB) at a maximum sensitivity of 100mV per centimetre. Calibrated attenuators enable the sensitivity to be reduced to 100V per centimetre, whilst a built-in a.c. coupled pre-amplifier can be used to increase the sensitivity to 1mV per centimetre with a bandwidth from 2·5 c/s to 50 kc/s. The sensitivity is thus continuously variable from 1mV per centimetre to 100V per centimetre. A highly linear time base generator provides sweep speeds continuously variable from 1μs per centimetre to 1 second per centimetre and an additional calibrated expansion of up to ten times is available. The h.t. and e.h.t. power supplies are obtained from silicon rectifiers.

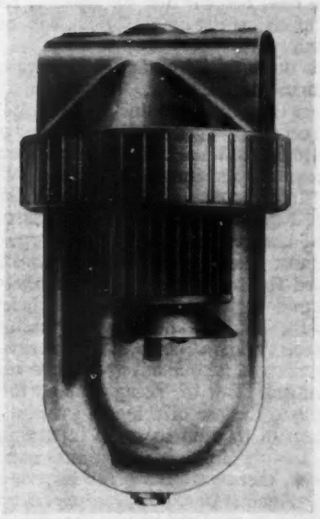
The instrument has a two-tone finish, and, as seen in the accompanying illustration, the grouping of the two sets of controls is emphasised by vertical and horizontal patterns in the separate panel backgrounds. Concentric adjustments where practicable have simplified the layout. The face of the tube has been brought out to the same plane as the control panels, so that the traces and relevant adjustments are in the same plane of vision and the operator does not receive the impression of focusing his eyes to look into a recess when turning his attention from the controls to the tube. Dimensions of the oscilloscope are approximately 9½in by 8in by 13in, and the weight is 22 lb.

[Reply Card No. E2732]

Air Pipeline Filters

A SMALL filter for use in compressed air lines introduced by Vokes, Ltd., Henley Park, Guildford, Surrey, is available with two forms of elements and fitted with either a metal or a transparent bowl, for working pressures up to 250 lb per square inch and 150 lb per square inch respectively. These filters, one of which we illustrate, are made for fitting in ¼in, ⅜in and ½in air lines.

The bowl is mounted by a clamping ring on the die-cast light alloy head on to a screwed stem



Transparent bowl air filter for pipelines with working pressures up to 150 lb per square inch

in which a quickly replaceable filter element is held by a butterfly nut. A tapped bore on one side of the head admits air into the centre of the filter element and the air filtered in its passage through the element passes from the bowl into the air line through a bore on the opposite side of the head.

A standard general purpose element is fitted for the removal of water, oil mist and grit where concentrations in the air are normal. When a high degree of air purity is essential an alternative pack element is fitted for the removal of oil or water mist. It is only necessary to remove the plug at the base of the filter element occasionally to drain off collected moisture and dirt, and the makers recommend that the elements should be replaced every six months to obtain optimum performance.

[Reply Card No. E2733]

Bench Muffle Furnace

A BENCH muffle furnace has been designed by Ferro Enamels, Ltd., Wombourn, Wolverhampton, to provide a compact unit for temperatures up to 1000 deg. Cent.

The sheet metal cased, heavily insulated working chamber consists of a nichrome wound muffle taking samples 18in deep by 5½in high by 7½in wide. A counterbalanced guillotine door operated by a chain and pinion is fitted.

Temperature control is effected by an infinitely variable regulator operating through a contactor relay. The furnace is normally rated at 2·75kW at 230V and is designed to attain a temperature of 800 deg. Cent. in two hours. It is stated that temperature uniformity is within 5 deg. from the front to the rear of the muffle.

[Reply Card No. E2734]

INDUSTRIAL NEWS

Iron and Steel Prices

The Iron and Steel Board has announced reductions in the maximum prices of iron and steel. These reductions became effective last Monday, February 8. Hematite pig iron has been reduced by 15s. a ton and the "extras" relating to basic pig iron have been amended. The price reductions in steel products are: heavy steel plates, 10s. a ton; heavy sections and joists, £1 a ton; tinplate, according to specification, on average £1 a ton. Further, the increase, averaging 8s. a ton of tinplate, which would have become due on April 1, following the recent rise in tin prices, will not be applied.

This is the third iron and steel price reduction since March, 1958; the combined effect of them is an overall reduction of from 2½ to 3 per cent in the general level of steel prices. The Iron and Steel Board's price policy, as expressed in its annual report for 1957, is that "in an expanding industry prices should reflect the costs of production and reasonable capital charges at new plant, incorporating the most modern techniques, favourably situated for raw materials and markets and operating at a high degree of efficiency." Since the last iron and steel price reduction, in June, 1959, the costs of ore, scrap, fuel, transport and labour have remained broadly unchanged. But the rising demand for steel has led to the use of a higher proportion of pig iron in relation to scrap in steelmaking and, as pig iron is the more expensive material, there has been a rise in production costs. Against this, however, experience has shown that modern plants are capable of greater outputs than were previously assumed and, consequently, the capital cost per ton of output is lower. The Board estimates that this has rather more than offset the higher production costs and has thus enabled certain prices to be reduced.

Steel and the Economy

In his chairman's statement at the annual meeting of Colvilles, Ltd., last Friday, Sir Andrew McCance said that, although the company's past year started in the middle of a trade recession, the subsequent recovery had been rapid. The demand for steel had been rising steadily during the past six months and there was every indication that that was likely to continue. This change, Sir Andrew observed, reflected the increasing confidence in the United Kingdom's prospects, both in the home trade and in export markets. It was a reflection of the confidence which had grown with the evidence of stability in costs and prices engendered by the success of the Government's economic policies.

But, Sir Andrew continued, the state of trade was very sensitive to changes in public sentiment and could be adversely affected by unrest and by wage demands which did not have increased productivity as their justification. There had been some signs recently that the pressures which caused the inflationary increases in the cost of living during the post-war years might recur and might upset the stability which had brought the return of good trade and employment. It was to be hoped, Sir Andrew added, that counsels of restraint in such matters would be followed so that the present expectations of prosperity throughout the country might be encouraged and prolonged.

Shipyard Hours

Following last week's meeting between representatives of the Shipbuilding Employers' Federation and the Confederation of Shipbuilding and Engineering Unions, the employers have now offered to discuss with the unions a reduction of the working week from forty-four hours to forty-two. In putting this offer to the unions, Mr. G. H. R. Towers, president of the Shipbuilding Employers' Federation, said that productivity in the shipyards had not risen to anything like the extent the shipbuilders were entitled to expect in view of the modernisation of the yards and methods of production. The employers had never sought to deny that many union members had co-operated in the introduction of new techniques and methods. But, Mr. Towers submitted, the unions consistently refused to recognise the justice of the employers' complaint that there were too many cases where the introduction of new machines met with resistance on the part of some, either on the question of the manning of those machines or on the wages to be paid to the men operating them. It was to be expected, he added, that there should be some difference of opinion on those matters. The employers thought, however, that any difficulties which arose ought to be settled by the process of negotiation through the industry procedure and not, as so often happened, by threats of strike action, bans on overtime and the like.

The offer of a forty-two-hour week, Mr. Towers emphasised, was being made bearing in mind the repeated statements of the union confederation's spokesmen that a reduction in the number of hours worked would not involve loss of production. The employers hoped, he said, that the unions would be prepared to co-operate by advising their members that every effort should be made to see that there was no loss of production. Recalling the recommendations of the 1957 Court of Inquiry into shipbuilding wages, Mr. Towers said that the industry to-day was no nearer to achieving the most efficient use of its manpower than it was in 1957. The troubles referred to in the report had not yet been resolved, although several meetings had been held. The employers were disappointed that at the last such meeting the union representatives had maintained in effect that there was no action which they could take to help resolve those difficulties.

The offer of a forty-two-hour week made no reference to the unions' claim for a wage increase. The offer, which is now in line with that already made by the engineering employers, was no doubt discussed by the union confederation at its meeting yesterday (Thursday).

Electrical Exports

The British Electrical and Allied Manufacturers' Association states that the electrical manufacturing industry exported products worth £285 million in 1959 or about £9,000,000 more than in 1958, and £6,000,000 more than in 1957. Expressed in round figures the main categories were generators, motors, switchgear, transformers and industrial equipment, £93,000,000; radio, electronic and telecommunications apparatus, £63,000,000; domestic appliances, £28,000,000; electric wires and cables, £25,000,000; and other products, such as instruments, X-ray apparatus, batteries and electric traction equipment, £74,000,000. Compared with 1958 the main increases in 1959 were £4,000,000 for steam and water turbines and £1,600,000 for electric motors. There was also a substantial increase in the radio, electronic and telecommunications group of products. The leading markets were India, Australia, South Africa, the U.S.A., Canada, New Zealand, and Rhodesia. A full analysis is not yet available but the existing information suggests that electrical exports to North America were of the order of £30,000,000, which was more than 10 per cent of the total and approached the combined figure for Australia and New Zealand. Exports to the Common Market countries were well maintained, a sharp fall in the total to France being more than balanced by an increase to Western Germany, mainly through the sales of electronic valves and apparatus. BEAMA states that last year's achievement was made against keen competition from Germany and other European countries, the U.S.A. and Japan and suggests that there are no signs of the competitive conditions becoming less stringent this year.

Wages, Hours and Costs

In an address, last Friday, to the National Production Advisory Council, the Chancellor of the Exchequer, Mr. Heathcoat Amory, urged that by "moderation and good sense" the possible dangers of overstraining the nation's resources could be avoided. He agreed that steady increases in real wages should be the national aim but said that if annual settlements were made on a scale going beyond the productivity increases which were being realised they would outstrip the likely increase in real wealth and endanger price stability. The Government, the Chancellor declared, realised its dominating responsibility for keeping a proper balance in the economy.

It was natural, the Chancellor continued, that in a period of expanding productivity people should seek to enjoy the benefits. Those benefits, he added, could come in various forms such as lower prices, higher wages, shorter working hours and higher profits. It became dangerous, however, if the total benefits people sought to enjoy added up to more than was available after meeting the claims of investment and export. The future, the Chancellor emphasised, must not be mortgaged by demanding benefits which had not yet been secured. The benefits of higher productivity, he went on, should not be absorbed entirely by increases in either profits or wages but should be shared with the consumer. Price reductions would do far more to consolidate the present prosperity than higher profit margins and dividends. Increases in real wages, the Chancellor said, could take the form of higher rates or shorter hours, but it was a delusion to think that reductions in working hours for the same pay were not equivalent to an increase in wage rates.

PERSONAL AND BUSINESS

Appointments

MR. L. J. CHENEY has been appointed chief information officer to the office of the Minister for Science.

BAKER PERKINS, Ltd., announces that Mr. F. Arnold Wilson has been appointed foundry machinery adviser.

MR. R. JOLLY has been appointed manager of the enlarged field engineering division of Benson-Lehner (G.B.), Ltd.

FOSTER, YATES AND THOM, Ltd., states that Mr. O. D. Gwilliam has been appointed to the new post of assistant general manager.

B.T.R. INDUSTRIES, Ltd., announces that Sir Walter Worboys has been elected to the board and appointed a deputy chairman.

MR. W. R. DEARDEN, A.M.I.Mech.E., has been appointed northern area manager of Highfield Gear and Engineering Company, Ltd.

BRITISH INSULATED CALLENDER'S CABLES, Ltd., announces that Mr. T. C. Johnston has joined the company as regional manager, eastern region.

THE BRITISH BROADCASTING CORPORATION has announced the appointment of Mr. C. J. Dolan, A.M.I.E.E., as engineer-in-charge, television, Belfast.

MR. D. G. FURZEY has relinquished his position with Monsanto Chemicals, Ltd., to take up an appointment as chief engineer with S. D. Plants, Ltd.

SIMMONDS AEROCESSORIES, Ltd., has appointed Mr. S. G. Preece, of Port of Spain, Trinidad, as its supervising representative for South America and the Caribbean area.

MR. H. W. A. WARING, managing director of Brymbo Steel Works, Ltd., has been re-elected chairman of the steel committee of the Economic Commission for Europe.

MR. J. R. EDWARDS, works superintendent and a special director of Shepcote Lane Rolling Mills, Ltd., has been appointed a director. Mr. F. Brown has been appointed a special director.

HEAD WRIGHTSON AND CO., Ltd., announces that Sir John Wrightson, Bt., vice-chairman and managing director, has been appointed to succeed Mr. Richard Miles as chairman and managing director. Mr. Miles has retired.

MR. A. E. STURDY, secretary of the Russo-British Chamber of Commerce (Inc.) for the past twenty-five years, has retired at his own request on reaching the age of sixty-five. Mr. H. E. S. Hayward has been appointed to succeed him.

THE DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH announces that Dr. D. T. Lewis has been appointed Government chemist in succession to Mr. E. H. Nurse, who retires on March 31. Dr. Lewis will take up his appointment on April 1.

THE BRITISH TRANSPORT COMMISSION announces the following appointments: Mr. P. I. Welding, senior scientific assistant, research department, has been appointed principal scientific officer; Mr. F. J. Pepper, carriage and wagon engineer, has been appointed mechanical engineer (general).

FOUNDRY SERVICES INTERNATIONAL, Ltd., announces that Mr. B. Howard Williams has been appointed a director of its Australian company, Foundry Services Australia Pty., Ltd. Mr. Robert W. Flint has been appointed general manager of the associated Indian company, Greaves Foundry Services Private, Ltd.

MR. F. W. TOMLINSON, managing director of Pyrotenax, Ltd., Mr. J. M. Willey, director and general manager of Murex Welding Processes, Ltd., and Mr. P. S. Bryant, of Murex, Ltd., have been appointed to the board of Murex, Ltd. Mr. Tomlinson has also been appointed a director of Murex Welding Processes, Ltd.

SIR WM. ARROL AND CO., Ltd., announces that Mr. W. I. French has been elected deputy chairman, Mr. Alfred Davis, formerly a special director of the Crane Works at Parkhead, has been appointed a director of the company, to be in full charge of the Crane Works. Mr. W. Reside will continue as a special director and has been appointed to chief engineer at the Crane Works.

FIBREGLASS, Ltd., has announced that Mr. P. J. M. Swiney has relinquished the appointment of market research officer to take up special duties as overseas sales promotion officer. Mr. Stanley Gaskell has been appointed market research manager. Mr. C. M. Johnson has taken over as area sales manager, north-eastern (England) area, and has been succeeded as Scottish area sales manager by Mr. R. Bowman.

Business Announcements

THE GENERAL ELECTRIC COMPANY, Ltd., Erith, Kent, states that its telephone number has been changed to Erith 33011.

SAUNDERS-ROE (ANGLESEY), Ltd., Beaumaris, Anglesey, North Wales, announces that the name of the company has been changed to Saro (Anglesey), Ltd.

HAYCOCK GAUGE AND TOOL COMPANY, Ltd., is the new title which has been adopted by the firm formerly known as A.H.T., Ltd., of Brays Lane, Coventry.

C. DAVIDSON AND SONS (PACKAGING), Ltd., Corinthian Manor Way, Erith, Kent, states that its telephone numbers have been changed to Erith 35426 and 35427.

THE BARNET DISTRICT WATER COMPANY, Station Road, New Barnet, states that on April 1 it will be amalgamated with the Lee Valley Water Company, Bishops Rise, Hatfield, Herts.

THE HONG KONG AIRCRAFT ENGINEERING COMPANY, Ltd., has appointed as its agent in Europe, Killick Martin and Co., Ltd., Dunster House, 20, Mark Lane, London, E.C.3 (telephone, Mincing Lane 3100).

MR. T. WHITE WILSON, a director of Plessey International, Ltd., is to make an extensive tour of the Union of South Africa and North and South Rhodesia. He sailed for Cape Town in the "Athlone Castle" on February 4.

JOHN LAING AND SON (HOLDINGS), Ltd., and LEX GARAGES, Ltd., announce that they have agreed to form a new company, Laing Lex, Ltd., for the purpose of sponsoring multi-storey and underground car parking facilities in London and the major cities of Britain.

SOLUS-SCHALL, Ltd., states that its sales, administration and accounts departments are now operating from its new address, County Building, Honeypot Lane, Stanmore, Middlesex (telephone, Wordsworth 4300). The service department will, for the time being, continue to operate from 15-18, Clipstone Street, London, W.1 (telephone, Museum 5080).

CLARKSON (ENGINEERS), Ltd., Nuneaton, states that due to the merger in Johannesburg of its agents, Wickman Machine Tools (Pty.), Ltd., and D. Drury and Co., Ltd., it has decided to open its own branch in Johannesburg and handle its distribution in South Africa. A new branch office has been opened at 119, Leicester Causeway, Coventry (telephone, Coventry 62724).

ALEXANDER STEPHEN AND SONS, Ltd., states that it has taken out a licenee from Turbin Aktiebolaget De Laval Ljungstrom to build De Laval marine steam turbine machinery at its shipyard and engine works, Linthouse, Glasgow. It has acquired exclusive rights of manufacture in Scotland, and non-exclusive rights of installation in any ships being built or repaired in the United Kingdom and British Commonwealth except Canada, and for ships being built or repaired for British owners in countries other than North America, Sweden and the Philippines.

THE ENGLISH ELECTRIC COMPANY, Ltd., states that a new project engineering group to provide close liaison between English Electric's aircraft equipment division and aircraft and aero-engine constructors has been formed. English Electric is supplying complete electrical generating systems for the "Vulcan" and "Victor" Mark 2's, "Canberra," "Lightning," "Javelin," Bristol 192 and "Jet Provost," and individual items of equipment for some twenty different aircraft and missiles. The new group is headed by Mr. T. E. Simms, chief project engineer.

THE WELLMAN SMITH OWEN ENGINEERING CORPORATION, Ltd., states that, due to the expansion of its furnace building and contracting activities, it has decided to segregate and operate the sales organisation of its furnace building department as a separate subsidiary company under the title of Wellman Smith Owen (Furnaces), Ltd., Parnell House, Wilton Road, London, S.W.1. The following executives of the parent company have been appointed directors of this subsidiary by way of addition to the board under the chairmanship of Sir Peter G. Roberts, Bt.; Mr. G. Talbot, Mr. C. D. Wattleworth, Mr. W. H. Day, Mr. C. Brooks, Mr. D. A. Hume. Mr. W. H. Day and Mr. V. Bellingham have been appointed directors of the Wellman Bibby Company, Ltd., and Mr. D. A. Hume has been appointed a director of Robinson and Kershaw, Ltd.

Contracts

LESLIE AND CO., Ltd., has been awarded the contract of approximately £500,000 for the new Royal College of Art building to be erected in Kensington Gore between the Royal Albert Hall and Queen's Gate. Consulting engineers are Clarke, Nicholls and Marcel.

THE POWER-GAS CORPORATION (AUSTRALASIA) PTY., Ltd. (a member of the Power-Gas Group), has received a contract from Sulphide Corporation Pty, Ltd., for the supply and erection of the charge handling plant for a new smelter being erected at Cockle Creek, near Newcastle, N.S.W. The value of the order is about £A300,000. The new smelter will utilise the blast-furnace principle to produce zinc and lead metal simultaneously.

HOLLOWAY BROTHERS (LONDON), Ltd., has been awarded a contract valued at £320,000 by the Southern Project Group of the Central Electricity Generating Board for the main foundations for extensions to the Bankside "B" Power Station at Southwark, London. These extensions will include new switch, boiler and turbine houses, work on which will commence in early 1961. The consulting engineers are Messrs. Mott, Hay and Anderson.

GEORGE WIMPEY AND CO., Ltd., has been awarded a contract for a second carriageway on the Great North Road between Redhouse and Wentbridge in the West Riding. The improved length of road will have two 24ft carriageways, a 15ft central reservation widening to 30ft at road junctions, and two 12ft verges. The scheme, which has been prepared by the West Riding County Council, acting as the Minister of Transport's agents, will link the Doncaster by-pass with the Wentbridge by-pass, and is one of 15 such schemes on the A.1 in the West Riding (see THE ENGINEER January 15 last, page 85). The county surveyor is Lt.-Col. S. M. Lovell.

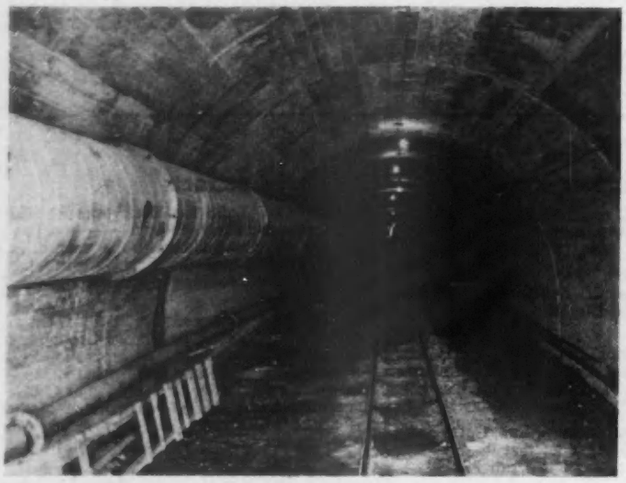
THE MARCONI INTERNATIONAL MARINE COMMUNICATION COMPANY, Ltd., acting on behalf of Marconi's Wireless Telegraph Company, Ltd., has negotiated an order for a television installation in the Orient liner "Oriana" which will enable television broadcast receivers to be used for reception of local transmissions in any part of the world. The installation, which has been designed and engineered by Marconi's Wireless Telegraph Company, Ltd., will provide for the reception of television broadcasts on the 405-line, 625-line, and 525-line systems, programmes being processed as necessary for closed-circuit distribution to the ship's receivers in a central television control room. The Marconi vidicon cameras used for this purpose will also distribute internal film programmes on local sequences while the ship is at sea. Some sixty receivers will be installed at first, but provision is made for increasing the number to nearly 400.

Miscellanea

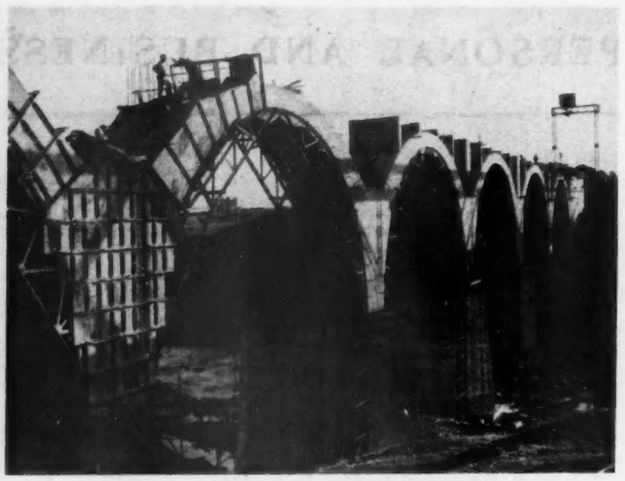
GAS IN INDUSTRY.—An exhibition illustrating "Gas at Work in Industry" to be held at the Royal Horticultural Hall, Westminster, from March 1 to 12, 1960, will be the second of its kind sponsored by Eastern, North Thames, South Eastern and Southern Area Gas Boards. The exhibition is designed to show how gas meets the demands of modern industry by the use of working plants, models, photographs, films, &c.

DIAPHRAGM VALVES.—A series of diaphragm valves in sizes from ¼in to 8in made by the Saunders Valve Company, Ltd., Cwmbran, Newport, Mon, are fitted with a P.T.F.E. diaphragm on a synthetic rubber backing. An attachment stud moulded in the diaphragm passes through the backing and facilitates speedy fixing to the valve compressor member. This new form of diaphragm can be used when handling all chemicals at room temperature and many chemicals at temperatures of up to 150 deg. Cent. under vacuum conditions or pressures up to 100 lb per square inch.

LIGHTWEIGHT SAFETY BELTS.—Demonstrations were given recently at the Shell Building, under construction on the South Bank site in London, of a new design of lightweight fabric safety belt and harness for constructional and other high-level workers which has been developed by Barrow, Hepburn and Gale, Ltd., Grange Mills, Bermondsey, London, S.E.1. These belts, of nylon and Terylene with high tensile steel and alloy fittings, have a breaking strength of over 2 tons and weigh only 2 lb. With a tool frog, one of the belts can be worn as a conventional waist belt and can be clipped on to safety lines, ropes or lifting harness when necessary.



This tunnel near Kraal Station is to be 1 mile long



Bridge across Vaal River under construction

Transvaal Railway Line Improvement

BY OUR SOUTH AFRICAN CORRESPONDENT

THE work begun on the Durban-Johannesburg main line in the Transvaal, stretching from Volksrust to Kaydale, a distance of 135 miles, in 1956, is now virtually complete. A new line has been built for this long stretch and large new sections between Standerton and Volksrust have already been opened to traffic.

The new line runs close to the old line, but is on an easier gradient and cuts straight through hills and passes through koppies and over embanked valleys. Tunnels at Kraal, Balfour, Koppie Alleen and Palmford, to a length of 11,700ft, are being built in connection with the straightening, and when all the tunnels are in use the overall length of the line will be reduced by 12 miles.

All the bridges are designed to take double tracks, embankments are being built for a single line, while cuttings through rock are built to double line formation. The existing gradient is being improved from 1 in 70 compensated to 1 in 80 compensated, while the minimum radius will be 40 chains. The classification of the new line will also be raised from a grade TA to a grade I, with a resultant increase in the maximum permissible speed from 55 to 65 m.p.h.

Some of the earthworks, culverts, station buildings, all the bridges, as well as the tunnel, 43 chains long, near Balfour, are being built under contract. The resident engineer in charge of the work is stationed at Standerton and controls a staff of 480 Europeans and 2350 non-Europeans. By the end of August, a total of 5,300,000 cubic yards of earthworks had been completed, with 426,000 cubic yards during the best month, and 68,000 cubic yards of concrete had been cast, excluding tunnels.

New Station at Heidelberg

A particular feature of the new construction is the entirely new station, entailing approximately 350,000 cubic yards of earthworks, being built at Heidelberg, while the line between Kaydale and Fortuna has been completely relocated to improve both standard and alignment. This entails a tunnel of just under 1 mile long, cutting under the national road and the present line at Kraal Station. We illustrate the interior from the entrance of the north portal of the Kraal tunnel, showing the lining in the heading, and the ventilation, air and water pipes. The tunnel will shorten the distance between Kaydale and Fortuna by about 3½ miles. The tunnel is driven in very poor material, necessitating concrete lining as the work proceeds. To speed up the work, a vertical shaft has been sunk at the centre through the roof of this tunnel to track level, where it is approximately 136ft below the surface. By excavating in both directions away from the shaft and from both outer ends of the tunnel towards the shaft, work is carried out on four faces simultaneously.

Both Elmtree and Teakworth stations are being relocated and the stations at other places are being remodelled in this section. Of particular interest is the fact that considerable difficulty is being experienced on this section with pot clay. Special materials have had to be selected for the embankments, while in a number of cuttings the clay has had to be removed to a depth of 3ft below formation level and backfilled with good material. The sections from Standerton to Kaydale are relaid with 519ft long welded rails on concrete sleepers. The rails are Thermit welded into half-a-mile lengths and special spliced joints are inserted every half-mile to cope with the expansion and contraction of each section. These long welded rails will ensure a much smoother ride, and maintenance costs will be greatly reduced.

New Vaal River Bridge

A reinforced concrete open spandrel arch bridge, consisting of six 60ft spans, is being built immediately south of Standerton across the Vaal River. It is illustrated above. The bridge deck, which has been designed to carry double tracks, is approximately 70ft above water level. The rail level on the new bridge will be 14ft higher than that on the old bridge.

Automatic Lighthouse for Wilnerton

THE Wilnerton lighthouse, the design of which is illustrated, is about to be put into commission and will be one of the most fully automatic beacons on the South African coast. Work was commenced in October, 1958, on the 70ft reinforced concrete tower with a lantern having an internal diameter of 7ft 1in and a main revolving optic of 250mm focal distance. The lighthouse will normally operate from the municipal electricity supply system, but in the event of a disruption in the service, an air-cooled diesel-alternator set will automatically provide the necessary current.

No resident staff will be attached to this lighthouse and there will be a visible alarm system of three coloured lamps which will be mounted near the top of the tower, beaming in the direction of the signal station in Table Bay harbour to communicate the conditions at the lighthouse to the staff responsible for its operation and maintenance. Three coloured lamps—red, green and white—will denote "intruder and fire alarm," "non-urgent alarm," and "urgent alarm" respectively.

The establishment of this navigational aid together with Robben Island and Greenpoint lighthouses will materially assist mariners in the approaches to Table Bay.

The Umhlanga Rocks lighthouse

Two similar installations are in operation on the Natal coast, at Cooper Light, and Umhlanga Rocks and have been functioning satisfactorily for five years. Thorn Bay (west coast), Yzervark Point (south-east coast), Cape Morgan (east coast) and Hangklip (between Hermanns and Gordon's Bay) are under consideration.

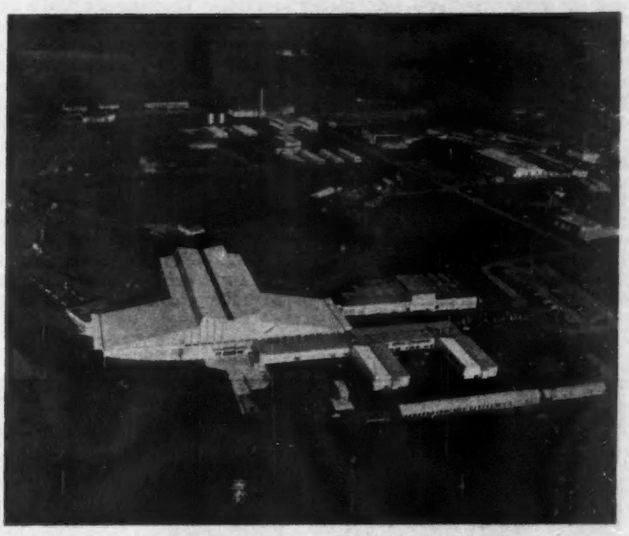
CONTINENTAL AFFAIRS

by Our Continental Editor

CERN Proton Synchrotron

No. I

The 25 GeV proton synchrotron is the second particle accelerator to go into operation at the Meyrin, Geneva, centre of CERN, the European Organisation for Nuclear Research. The first CERN accelerator, a 600 MeV synchro-cyclotron, was built in 1957. The proton synchrotron, which is described below, was designed in 1954 and became operational last year. It is the first machine of its kind to use the alternating gradient principle with strong focusing and an enormous saving in the weight of magnet steel. It has already produced particles with an energy of 28·3 GeV and beam intensities higher than expected.



THE CERN 25 GeV (or 25,000 MeV) proton synchrotron which was formally inaugurated by Professor Nils Bohr on February 5 is, for the time being at least, the most powerful particle accelerator in the world. This distinction is likely to be temporary, for a similar but slightly larger machine of 30 GeV maximum energy is being built at Brookhaven, U.S.A., and a 50 GeV is being built in Russia. In the meantime, however, the CERN proton synchrotron (CPS) accelerates protons to an energy about three times that of the next most powerful machine, the Synchrophasotron at Dubna, in the U.S.S.R. (see Table I).

TABLE I—*Proton Accelerators Completed or Under Construction*

Accelerator	Maximum energy, GeV	Mean intensity, particles per second	Completion date
Brookhaven proton synchrotron (Cosmotron)	3	$2 \cdot 10^{10}$	1952
Saclay proton synchrotron (Saturne)	3	10^{10}	1958
Princeton-Pennsylvania proton synchrotron	3	$2 \cdot 10^{11}$*	1960
Berkeley proton synchrotron (Bevatron)	6	$2 \cdot 10^{10}$	1954
Rutherford Laboratory proton synchrotron (Nimrod)	7	10^{12}*	1961/62
Russian A.G. proton synchrotron	7	$\approx 2 \cdot 10^{10}$*	1960
Russian proton synchrotron (Synchrophasotron)	10	$\approx 10^{9}$	1957
Australian proton synchrotron	10	10^{12}*	1962/63
Argonne zero gradient proton synchrotron	12·5	$2 \cdot 10^{12}$*	1962
CERN proton synchrotron	28	$2 \cdot 10^{9}$	1959
	25	$3 \cdot 10^{9}$	
	6–10	10^{10}	
Brookhaven A.G. proton synchrotron	30	$\approx 3 \cdot 10^{12}$*	1960
Russian A.G. proton synchrotron	50	$\approx 10^{12}$*	1961/62

* Indicates target figures.

The CPS will be a very powerful instrument for the systematic study of the properties of all known particles and of their mutual actions and behaviour in energy ranges up to and exceeding 25 GeV. It may well open up the possibility of the discovery and investigation of new particles. An important characteristic is its high beam intensity which should enable high velocity mesons to be generated in quantity. Already the CPS has been operated at a beam intensity ten times higher than that originally planned.

The history of the CPS is interesting. It may be recalled that in June, 1952, the interim council of CERN decided to begin an engineering design study of a 10 GeV proton synchrotron which was envisaged as the main high energy particle accelerator for the European centre for nuclear physics research. In August, when a small design study group visited the "Cosmotron" particle accelerator at Brookhaven and learnt of an interesting idea (known as the "alternating gradient principle") for greatly reducing the cost of a machine such as that envisaged: alternatively, it gave promise of allowing a machine of much higher energy to be built for a given cost. This idea so impressed the study group that it was able to persuade the CERN engineering council to abandon the study of the 10 GeV machine and to start a theoretical study of the new principle in the belief that it might lead to the development of a 30 GeV machine for about the same cost as that of a 10 GeV machine based on the Berkeley "Cosmotron." Various technical aspects of the proposition were studied at a number of centres, including Harwell, Copenhagen, Paris, Heidelberg, Freiburg and Bergen, and by October,

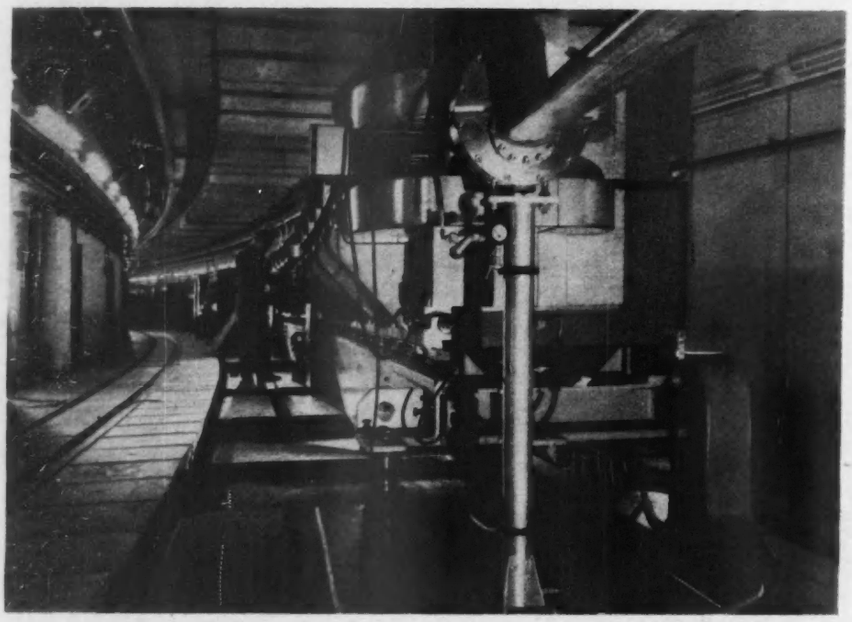
Interior of the ring building of CERN's (25 GeV) alternating gradient proton synchrotron. A few of the 100 units of the 3800-ton electromagnet can be seen on their shock-proof concrete supporting girder, which is architecturally independent of the ring building

CONTINENTAL AFFAIRS *(Continued)*

1953, the work had progressed sufficiently to enable a tentative design to be submitted to the CERN council.

It was then decided to proceed with the design of a 25 GeV machine, and a site at Meyrin, near Geneva, was chosen. Development of the components of the machine went on in 1955, and the major contracts were placed in 1956. The next two years were taken up with the manufacture of the components and their assembly and installation on site. Testing and commissioning of the machine (which by then had become known locally as CPS) took place in 1959.

By the end of November protons were being accelerated to energies corresponding to 24 GeV, or 96 per cent of the design value. A few weeks later, by making use of pole face windings to modify the shape of the magnetic field at values above 12,000 gauss, it was found possible to increase the maximum energy to 28 GeV. Measurements that were made showed the intensity of the accelerated beam to be 10^{10} protons per pulse. Exceeding all expectations, there was no detectable loss of particles throughout the acceleration period, up to the maximum energy.



Interior of the ring building of the CERN (25 GeV) strong-focusing alternating-gradient proton synchrotron. Here the electromagnet is seen under construction; at the right is part of the 7 × 14·5cm vacuum chamber, 628m long, in which the protons are accelerated

The building and commissioning of the CPS has progressed well ahead of schedule—a result which reflects great credit on the effectiveness of the collaboration between Mr. J. P. Adams (Director of the PS division), his staff recruited throughout Europe, and the contractors, numbering several hundreds, from European and other countries.

Principle of Operation

Protons to be accelerated in the CPS originate from ionised atoms of hydrogen in an ion source and then enter a Cockcroft-Walton preliminary accelerator, where their kinetic energy is raised to 500 KeV. Further acceleration then takes place in a three-stage Alvarez linear accelerator which increases the kinetic energy to 50 MeV. Then the particles are injected tangentially into a ring-shaped vacuum chamber of 14cm by 7cm elliptical cross section and 200m diameter. Sixteen accelerating cavities spaced round this ring raise the kinetic energy of the protons. At the same time the magnetic field produced by 100 magnet units embracing the vacuum chamber ring keeps the beam focused on an orbit of 200m diameter in the chamber. The magnetic field is increased rapidly to provide the required focusing effect, matching the increased kinetic energy of the protons with each circuit of the orbit. A system of pick-up electrodes and feed-back circuits contributes to accuracy of the focusing.

Peak energy of the beam, nominally 25 GeV, corresponds to particle velocities of about 99·94 per cent of the velocity of light. At this point the beam can be made to strike a target and the trajectories of particles resulting from the collision can be recorded on photographic emulsions. Alternatively, it is proposed to eject the beam from its circular orbit and to deflect it towards particle counters, bubble chambers or cloud chambers placed in one of the two experimental halls adjoining the synchrotron itself. The subterranean ring-shaped accelerator building can be seen behind the experimental halls on the left of the upper illustration on page 277.

Shielding against radiation is provided by barytes concrete and access to the machine is prevented while it is in operation, while control is exercised from remote operations rooms.

Particle Injection

The protons to be accelerated are derived from an ion source consisting, essentially, of a ceramic pot in which hydrogen is ionised by a 140 Mc/s pulse of 30μsec duration. The pressure needed in the discharge tube is 10^{-2} Hg and in the accelerating region is 10^{-6} Hg. These desiderata led to the choice of a channel of 3mm diameter and 15mm long. The extraction voltage is 25kV applied for about 10μsec and the output current is 50mA to 100mA.

Protons from the ion source are first accelerated in a 600kV, 4mA Cockcroft-Walton generator consisting of a symmetrical cascade arrangement and driven by a 5kVA, 50 c/s transformer, with selenium rectifiers. Both the transformer and the cascade elements are enclosed in an oil-filled insulating cylinder 4m high. Twelve stainless steel discs alternating with thirteen porcelain rings constitute the accelerating column, which is 83cm long, the voltage gradient being 6kV/cm. A resistor-capacitor chain ensures that the voltage distribution is uniform under transient and steady state conditions. The whole 600kV generator set is shielded by being enclosed in a Faraday cage 10·5m by 8·5m by 6m high and made of aluminium sheet.

Protons from the Cockcroft-Walton set are injected into the Alvarez type linear accelerator which is in the form of three cylindrical resonant cavities, each consisting of a copper liner and a series of drift tubes disposed along the accelerator axis. The three cavities are mounted in series in an evacuated envelope and are fed with r.f. power. To suit the value of the remanent field in the magnet and the r.f. accelerating programme, 50 MeV was adopted as an economic value for the energy of the particles injected into the proton synchrotron.

The three resonant cavities are 6m, 12m and 12m long, giving output energies of 10 MeV, 30 MeV and 50 MeV respectively. In the first of the resonant cavity tanks there are forty-two drift tubes and their diameter decreases from 140mm to 62mm. In the second and third tanks the drift tubes are of constant diameter.

TABLE II—*Main Particulars of CERN 25 GeV Proton Synchrotron*

Maximum kinetic energy at 12,000 gauss	= 24·3 GeV
Maximum kinetic energy at 14,000 gauss	= 28·3 GeV
Magnetic radius	r_0 = 70·079m
Mean radius	r = 100m
No. of magnet units	N = 100
Length of magnet unit	4·30m
Length of normal straight sector	1·60m
Length of long straight sector	3m
No. of linear lenses	10 pairs
No. of non-linear lenses	20 pairs
Magnet and power supply :	
Magnetic field :	
At injection	147 gauss
For 24·3 GeV	12,000 gauss
Maximum	14,000 gauss
Weight of one magnet unit	38 tons
Total weight of coils (aluminium)	110 tons
Total weight of iron	3400 tons
Rise time to 12 kgauss	1 second
No. of cycles per minute (12 kgauss operation)	20
Peak power to energise the magnet	34,600kW
Stored energy	10^5 joule
Mean dissipated power	1500kW
Magnet gap at equilibrium orbit	10cm
Tolerances :	
Alignment tolerances :	
Vertically	0·3mm r.m.s.
Horizontally	0·6mm r.m.s.
Radio frequency :	
Energy gain per turn	54 keV
Stable phase angle	60 deg.
No. of accelerating cavities	16
Length of cavity	2·3m
Harmonic number	20
Frequency range	2·9—9·55 Mc/s
Power per cavity	6kW
Injection :	
Injection energy	50 ± 0·1 MeV
Injection field	147 gauss
Length of linear accelerator	30m
R.F. power	5MW at 202·5 Mc/s during 200μs
Vacuum system :	
Vacuum chamber :	
Length	628m
Section	7 × 14cm
Wall thickness (stainless steel)	2mm
Vacuum pumps	4 + 67 stations
Pressure, better than	10^{-6}mm Hg

The r.f. supply is common to the three cavities and consists of a quartz crystal oscillator and amplifier, with one output stage for each cavity. The power ratings of the three cavities are, respectively, 1MW, 2MW and 2MW at 200 Mc/s, with a pulse duration of 200μsec and a pulse repetition rate of 1 p.p.s.

Focusing in the drift tubes is effected by alternating gradient magnetic quadrupole lenses in the second and third cavity systems. Originally grids were used for focusing in the first cavity (as in the linear accelerator at the Lawrence Radiation Laboratory, Berkeley) but they were later replaced by pulsed quadrupoles.

(To be continued)

Laying of 170kV Submarine Cable in Denmark

In the course of constructing a 150/170kV grid, a 2km long submarine cable of the Mollerhoj flat design has been laid across Kolding Fjord between Jutland and Funen. The heavy cable, stated to have the highest voltage rating at present employed in submarine work, was laid by means of a floating drum.

ON December 5, 1959, the installation of a 2km long Mollerhoj flat submarine cable designed for a maximum voltage of 170kV and a transmission capacity of 215MVA, was completed in Denmark. This cable is to be put into service this month, when the construction of the adjoining 150/170kV grid section has also been completed.

The cable is noteworthy partly by reason of its size—it weighs 48·2 kg per metre and has overall dimensions of 112mm by 180mm—and partly because it is the first three-core submarine cable in the world for such a high voltage. It forms part of the 150kV grid which is under construction in Jutland and in Funen. In addition to about 10km of flat land cable for 170kV, this extension of the power system has made it necessary to lay the above-mentioned submarine cable under Kolding Fjord in order to connect the Skærbæk power station and the South Jutland power station with each other.

Cable.—The design and mode of operation of the flat cable have been described in detail elsewhere, so that only a brief résumé, with special reference to the design used in the Kolding Fjord, is given in this article.

The cable is shown in Fig. 1. Three 310 square millimetre screened circular copper conductors, each insulated with a 13mm thick paper wall, are laid together side by side in flat formation enclosed in a lead sheath. The lead sheath, which is 55mm by 153mm overall, is supported by a membrane reinforcement consisting of two layers of copper band applied circumferentially and two layers of corrugated bronze tape lashed with two copper wires to both flat surfaces of the cable.

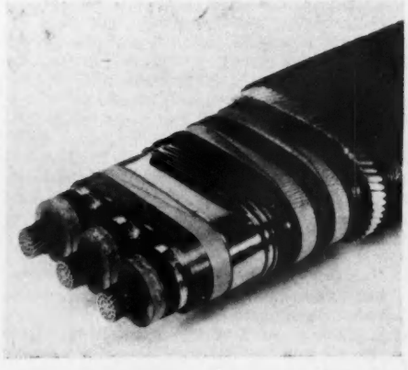


Fig. 1—Mollerhoj three-core flat submarine cable

The cable is armoured with sixty 5·16mm galvanised steel wires. Anti-corrosion protection is provided between the membrane support and the submarine armour, and a jute protection is placed over the submarine armour.

The dielectric consists of graded paper insulation fully impregnated with low-viscosity oil. An increase of the load in the cable and the temperature rise involved thereby will cause the oil to expand, such expansion being compensated by an outward deflection of the flat sides of the cable which work as beams under uniformly distributed loads. The corrugated bronze tapes fitted on the flat sides ensure that the deflection is elastic and at no-load the cable will resume its original shape. In this manner the cable is self-compensating, which means that there is no need for provision and maintenance of diaphragm expansion tanks. Moreover, no longitudinal flow of oil takes place in the cable; hence no significant pressure changes are produced on short-circuits or sudden no-load conditions, and one can use an impregnating oil with a higher viscosity than in the conventional oil-filled cable. Such an oil makes it possible, when jointing successive lengths of cable, to seal the ends by simply freezing them next to the joints with carbon dioxide snow. This enables a thorough vacuum treatment and oil filling of the joints to be carried out.

In spite of its three-core construction, the flat cable is very convenient due to its high flexibility about the long axis.

Manufacture.—The cable for Kolding Fjord was manufactured in four lengths of about 500m each, and the manufacture did not differ materially from that of the conventional oil-filled cable. After application of the submarine armour the four lengths of cable were transported to the harbour at Copenhagen and were there joined together by means of flexible junction boxes and wound on to the floating cable drum.

Flexible Submarine Cable Junction Boxes.—The copper conductors were screwed and soldered together, using junction ferrules of the same diameter as the conductors, and the insulation was applied in the usual way. The joint is contained in a flat corrugated copper tube, which is plumbed to the cable sheaths. The plumbings are protected from cracking by short flat copper rods fitted lengthwise and lashed with copper wire. The corrugated copper tube as well as the adjoining cable ends, are reinforced with heavy corrugated bronze tapes in order to prevent the flat sides of the copper tube causing membrane movement and at the same time to maintain the flexibility of the junction box (see Fig. 3). After the junction box has been provided with anti-corrosive protection, the armouring is re-established by letting the armouring wires from both cable ends overlap the box and binding the overlapping lengths with wire.

The junction boxes are evacuated and filled with oil, the oil in the adjoining cable ends being subjected to freezing during the process. Joining the four lengths and winding the cable on the floating cable drum took about three weeks.

Floating Cable Drum.—This device, shown in Fig. 2, was built by A/S The Northern Cable and Wire Works, Copenhagen, in 1954, and has so far been in operation at five cable layings in Danish waters—the latest being the Kolding Fjord crossing.

The drum is 6m in diameter and 11m long, with a 10m long cylindrical section, and when fully loaded will hold about 300 tons of cable. By means of brakes, the discharging speed can be regulated, enabling the pull on the cable and the slack required by the water depth to be kept under full control during the laying operation.

Cable-laying from a floating drum imparts a gentler treatment to the cable than does laying from coil on shipboard, because the cable will not be subjected to simultaneous torsional and bending strains and because the bending diameter will at no time be less than the diameter of the floating drum. A further advantage of the floating drum is its small draught which enables it to be operated close to the coast even in shallow waters.

However, laying by coiling has also been done with flat cables up to a length of 10km and in 100m water depth, and this method, it is stated, has not presented any difficulties.

Cable Route.—The greatest water depth in the case of the Kolding Fjord cable run was only about 14m, but an examination of the Fjord bottom revealed that at the southern end the cable would be laid on a layer of mud up to 10m thick, and in the middle of the run the cable would come to lie on an even thicker mud layer. It was feared that by sinking into the mud the cable might be suspended between two points and might even come to hang by the southern end box, which is located right at the water's edge. It was therefore decided to leave a slack somewhat larger than normal practice requires. By laying the cable in four bights, each having a deflection of about 30m from the line of sight between the two shore points, it was possible to include a surplus length of 5 per cent.

Laying.—The laying was accomplished by a close co-operation between the customer, the South Jutland power station, the contractor, the Danish firm Em. Z. Svitzer's Salvage Company, and the cable supplier, The Northern Cable and Wire Works.

The South Jutland power station had previously erected beacons on both shores to indicate the cable route and also provided the necessary means of communication and the manpower required to haul the cable ashore. The Northern Cable and Wire Works were responsible for the correct and proper treatment of the cable.

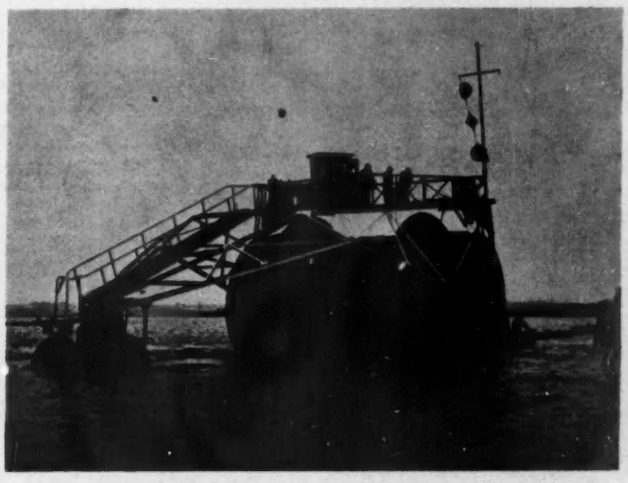


Fig. 2—Floating drum for placing heavy section submarine cable. The drum can hold about 300 tons of cable, can work closely inshore, and its use avoids twisting the cable

The floating drum carrying the cable was towed to the laying point by the salvage vessel "Bien" (600 h.p.). On the same day the 300-ton lighter "Frigga" arrived at the harbour of the Skærbæk power station with winches, wire, ropes, empty oil barrels lashed together in pairs, and other equipment. During September 19 the necessary preparations were made to start the laying the next morning: winches were put up, a wire rope was run out to the floating drum, and buoys were put down at several points between the shores to indicate the water depth. At 7 a.m. on the next day, the floating drum was towed as near as possible to the northern coast and stationed about 600m from the shore in the line of sight between the beacons. An hour later, the hauling ashore of the cable by means of a 5-ton winch sited on the beach was commenced. A pair of oil barrels was placed under the cable for about every 5m of cable unwound from the floating drum, the end being carried by a pontoon. The cable passed over a pulley on the pontoon, which enabled the latter to be moved along the

CONTINENTAL AFFAIRS *(Continued)*

Fig. 3—Flexible joint without anti-corrosion protection and armouring wires. The corrugated copper tube and the adjoining cable ends are reinforced with heavy corrugated bronze tapes

length of the cable afterwards in order to remove the oil barrels from the shore out to the floating drum. At 1 p.m., 600m of cable had been laid on the fjord bottom. Thereafter, in the period between 1 p.m. and 2.30 p.m., about 1km of cable was laid direct from the floating drum, which was towed by a 300 h.p. motor-boat and held in place against the current by a 50 h.p. motor-boat.

The floating drum was able to go as near as about 500m from the south coast. The remaining cable was laid on oil barrels parallel with the coast and was hauled ashore by means of two 3-ton winches. The laying operation was completed at 5 p.m. after the oil barrels had been removed.

Throughout the operation, communication was maintained between the shore winches, the floating drum, the tug and the pontoon by portable radio-telephone. Furthermore, a telephone connection was established during the landing operation on the north coast by means of a field cable between the floating drum and the landing winch. Accordingly, the braking of the floating drum, the placing of the barrels, and the pull by the winches were all controlled from the floating drum.

The whole cable was examined by a diver the day after laying, who found that nowhere was it endangered by rocks, and no parts of it were freely suspended. The cable had already been buried in mud on part of the run where the bottom was softest.

Conclusions.—The flat design of cable, it is stated, has acquired a reputation for being particularly well-suited for submarine lines on account of its self-compensating construction and because by placing the three conductors side by side it is possible to manufacture long lengths with high flexibility. So far it has been used for twenty-eight submarine cables, representing a total length of cable of about 65km.

Although in the present case it was not necessary to lay the individually manufactured lengths separately and splice them at sea, this has been done in one case, viz., the laying of the first of the 132kV flat cables under the Sound between Denmark and Sweden, in order to gain experience of joining at sea with a view to the possibility of later repairs.

A short cable can often be laid with advantage by floating it across the channel on empty barrels and afterwards removing the barrels. Small and light cables may alternatively be laid from a drum mounted in a barge.

Long, flat cables can also be laid from coil on shipboard. This method has been used, for instance, for two lines of 3 by 35 square millimetres 33kV cables, one of which was 2km and the other 9km long. For large and heavy cables the use of the floating cable drum as described above in the case of the Kolding Fjord is to be preferred.

Owing to the fact that the conditions which are connected with the laying of a submarine cable are often complicated, these cable lines are liable to attract attention at the expense of the land cables. The impression created by this, that the flat cable has been used chiefly for submarine purposes, is, however, incorrect. In the course of the last eighteen years, more than 420km of flat cable has been delivered, of which only about 16 per cent were for submarine lines, the rest being installed on land.

Urban Roads in Cologne

THE rapid rate of construction of new roads in Western Germany has been commented upon quite recently in this journal on several occasions. Apart from its vastly greater scale, the German road programme differs from its British counterpart in the effort which is being made in the central districts of large towns. Practically all the major industrial centres have energetic programmes of road works in progress, so the facts given here about the new roads under construction or planned for the central areas of Cologne may be taken as typical.

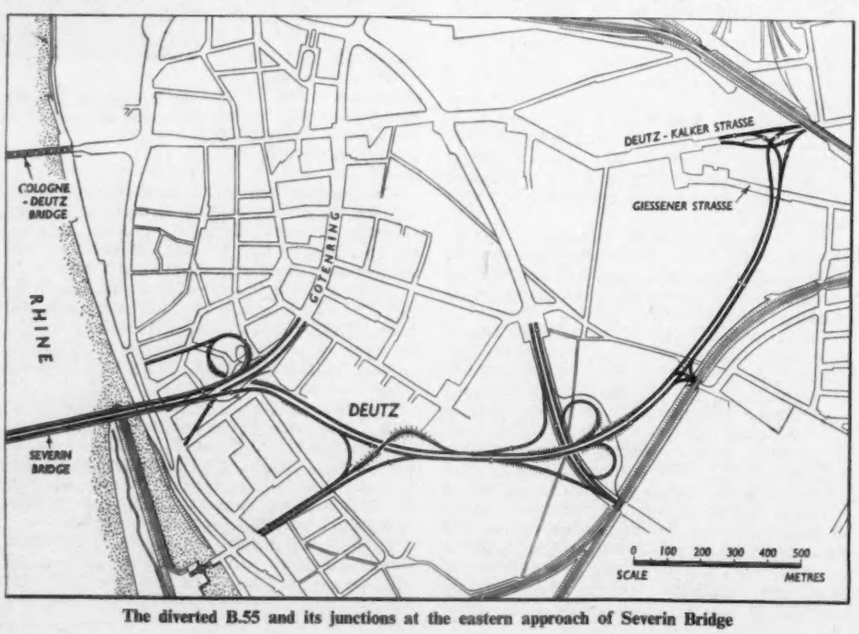
A focus to these schemes is given, in Cologne, by the Rhine crossings which attract considerable traffic. The Cologne–Deutz bridge which was completed in 1950, gave a new highway crossing close to the famous railway bridge, which, it was thought, would be adequate for many years. This bridge is a slender steel structure of box construction in high tensile steel (see THE ENGINEER, March 17, 1950) and was an early example of the post-war trend in Germany towards slender and rather advanced design, in structural steel generally, and in bridges in particular. The German Federal Highway B.55 crossed the Rhine on this bridge. Cologne has a population of about 750,000, and for the sake of simplicity, the city can be very roughly pictured as centred on a cross of which the north–south arm is the Rhine, and the east–west arm is the old B.55 route crossing the Rhine on the Cologne–Deutz bridge. (It would be more accurate to point out that the city centre is to the west of the river, and the "centre of gravity"—say, the cathedral—is in the north-west quadrant of this cross.)

Since the completion of the Cologne–Deutz bridge, however, the traffic problem has become much more serious, and it is stated that traffic has increased six-fold in the narrow city streets in the past ten years. The "population" of motor vehicles has increased by 62 per cent in ten years, and now 54,000 vehicles cross the Cologne–Deutz bridge daily, as compared with 29,000 a few years ago. As a result a second road bridge—the Severin bridge—has been built across the Rhine to the south of the Cologne–Deutz bridge.

The Severin bridge has also been described in this journal (see THE ENGINEER, September 18, 1959). It is as intriguing structurally as the Cologne–Deutz bridge, but its design is stolidly and teutonically ugly, an antithesis of the grace of the earlier bridge. These aspects of it need not concern us here, however, our principal interest being centred on the system of roads into which it is integrated. The B.55 route has been diverted at the eastern and western limits of the city, and follows a new path through Cologne to the south, such that it crosses the Rhine on the Severin bridge.

APPROACHES TO SEVERIN BRIDGE

Full motorway standards have not been achieved on this new route, but it is nevertheless characterised by a close approach to these standards, and by elaborate intersections with grade-separation and segregation of the various



The diverted B.55 and its junctions at the eastern approach of Severin Bridge

traffic streams for a considerable part of its length. Thus the approaches to Severin bridge are quite complex, and are equally in strong contrast to the approaches at the Cologne–Deutz bridge, where in 1950 it was considered sufficient to rely on simple arrangements with traffic lights.

The sketch reproduced opposite shows the layout of the B.55 as it leaves the Severin bridge on the eastern bank of the Rhine (i.e. in the suburb of Deutz). The arrangement is not as complex as that at Mannheim, illustrated in our issue of January 1, but the same general approach, which aims at not limiting the capacity of the bridge to that of inadequate access roads, is apparent. Complete segregation from existing streets and no crossing of traffic lanes by pedestrians or cyclists has been achieved. Quite elaborate loop roads communicate with the city, even though the area was densely developed. The actual road structures are of prestressed concrete and are slender and attractive in appearance. This new section of B.55 joins the old route at the Deutz–Kalker Strasse on the right of the sketch. The new route was carefully selected to route traffic away from the Cologne–Deutz town centre. Oddly enough there are pedestrian crossings on the new B.55 carriageways at its junction with Giessener Strasse, which would appear to be rather hazardous. But this section is still under construction, and the arrangement at this junction may well be temporary.

Our second sketch shows the B.55 and its junctions as it joins the Severin bridge on the west bank of the Rhine, in the heart of Cologne. The junction with the Nord-Sud Strasse is the first stage in turning the latter road into a main road passing in the north-south direction, right through the city centre, with multi-level intersections.

From this junction, the new section of the B.55 on the western bank extends west and then north-west, for a distance of about 3km, where it joins its original route on the Aachener Strasse. This length of road has junctions on the level, and it thus has a timed system of traffic light controls—a "green wave" system as it is called—which enables vehicles to travel along the whole length of the road at the control speed (generally 50km per hour) without having to stop. The road has three traffic lanes in each direction.

Innere Kanalstrasse

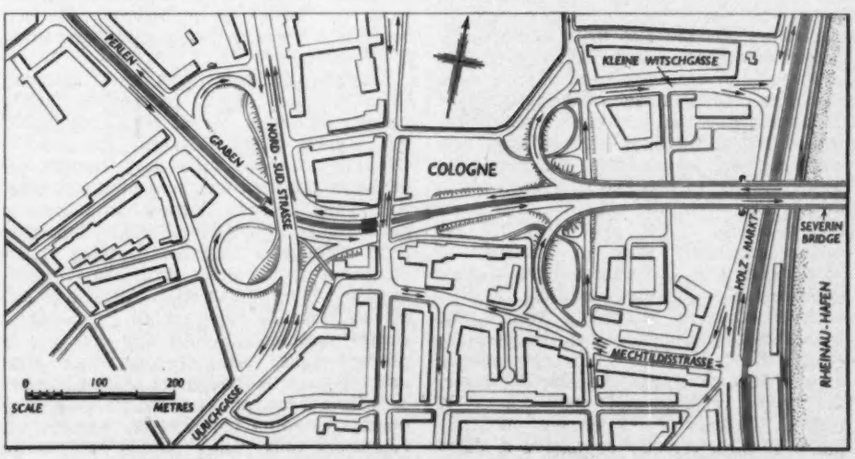
A second express road projected in Cologne is the Innere Kanalstrasse which forms a quarter-circle around the north-western part of the central area, and then will continue down the west bank of the Rhine towards the city centre. It will distribute traffic from the north to various parts of the centre of Cologne and its suburbs, and it will be possible to reach any point in the central area in three or four minutes from this road. Intersections will have waiting bays for traffic turning left, and traffic signals will operate on the "green wave" co-ordinated control system so that vehicles will travel the whole stretch of road with no delays. A later feature of this new road will be the North Bridge (Nordbrücke), which will constitute a link between the western ring road and the express roads in the eastern parts of the city.

The north quadrant of the Inner Kanalstrasse has already been completed and has dual carriageways over a length of 4·8km. The carriageways are each 8·5m wide, separated by a 3m wide central reservation. There are cycle tracks and footways on each side. Construction of the carriageways is with a sub-base of rubble hardcore 30cm thick, placed on the compacted subgrade, a 25cm layer of blast-furnace hardcore, and a levelling course of tarmacadam. A 6cm thick bituminous surfacing is provided.

Parking Garages

In the central area of Cologne there are now six completed parking garages, with a total capacity of 1775 vehicles. Two new parking garages, which will accommodate another 1000 vehicles, are under construction. These garages are designed so that further garages can be built on top of them when the number of vehicles in the city increases. Public parking space for 2034 vehicles is also available in the central area and it is planned to provide a considerable amount of additional parking space. Cologne thus occupies a leading position among the major German cities as regards parking facilities.

The parking garages in Cologne are provided with ramped access ways in preference to lifts; during rush hours, the latter require additional parking space for cars arriving and departing and it is considered that such extra space is not available. The cost of these parking garages varied from DM.3000 to DM.7000 per unit parking space. The Municipality of Cologne has not shared in the cost, but has assisted with advice and in the acquisition of land.



Layout of approach roads on the eastern bank of the Rhine at Severin bridge

Automatic Welding Installation

During the last few years, great strides have been made with the fabrication of machine parts, in particular large items, by the introduction of heavy bending presses and advanced welding techniques, including automatic welding.

Etablissements Neyrpic, of Grenoble, recently designed and built a machine for the welding of hydraulic turbines, a field which makes great demands both as regards accuracy of dimensions and reliability of the product. Our illustration shows the manipulator of this machine which can handle workpieces of up to 30 tonnes. These are mounted on a cast steel turntable of 13 tonnes weight which can be inclined and rotated by mechanical and hydraulic operation. In this way, the workpiece is presented correctly to the electric arc welding head which is mounted on a travelling arm. Welding currents of up to 1500A can be employed.

Welding manipulator for workpieces, especially turbine components, of up to 30 tonnes weight. The manipulator works in conjunction with an automatic arc welding head

The machine is operated by means of about a dozen push-buttons by a single operator.

Low-Filtration X-Ray Tube

A low-filtration X-ray tube suitable for use with the "MG 150" unit has been developed by C. H. F. Müller, Hamburg (sole U.K. agent: Research and Control Instruments, Ltd., Instrument House, 207, King's Cross Road, London, W.C.1). The tube, rated at 150kV, has a dual focus and shield, with a beryllium window. It is intended to meet the needs of the plastics, rubber and light alloys industries, where a very low-filtration tube is required if the best results are to be obtained. Another application is the irradiation of biological specimens where the high specific X-ray output is of importance. It is claimed that up to 135,000 roentgens can be obtained and that, at present, this is the only 150kV tube with a filtration of 3mm of beryllium. The tube foci are 0·7mm and 2·5mm, for which the maximum loading on "MG 150" unit is, respectively, 600W and 1800W. The emergent beam forms an angle of 40 deg. A supply of cooling water is required at a minimum rate of 4 litres per minute.

So as to facilitate the irradiation of biological samples with a high irradiation intensity, the distance between X-ray port and focal spot has been kept as short as possible. A minimum distance of 70mm can be obtained between focal spot and sample (lower edge of mechanical snap lock). By removing four screws and taking off the snap lock and baseplate, the focal spot can be brought to a minimum distance of 33mm from the sample (lower edge of the housing head).

THE AMERICAN SCENE

by Our American Editor

Potential Power Sources

Much discussion in the United States to-day concerns the various efforts to generate power in unconventional ways. Some methods seek to tap entirely new, or at least different, sources. In this category are solar batteries, wells to bring geothermal steam out of the ground, and systems to harness the power of the tides. Secondly, there are new devices for converting heat to electricity—among them dynamic heat engines, thermionic and thermoelectric converters, and magneto-hydrodynamic generators. In a third class are the attempts, like those of N.S.U. and Curtiss-Wright, to develop a more efficient internal combustion engine. Finally, there are the fuel cells, which seek to produce power continuously through electro-chemistry. Interest in new methods of generating power has been stimulated in part by fears that supplies of petroleum and natural gas soon may be exhausted. The demand for power is expected to double by 1975, while the proven reserves of these fuels, from which 70 per cent of U.S. electricity now is generated, are said to be sufficient for only thirteen years in the case of oil and twenty-three years in the case of natural gas at present rates of consumption. Progress in lowering the cost of atomic energy to permit it to compete with fossil fuels has been disappointingly slow. Hence, some industrialists have concluded that the next few years will witness an overwhelming demand for solar batteries, fuel cells and other such " gadgets." However, in the immediate future, a far more significant factor in speeding the development of unconventional power sources will be the missile programme. Rockets, particularly those designed for exploration of outer space, require long-lasting, lightweight, high-output electric generating devices to power their electronic gear. For this reason, the U.S. Army is sponsoring research and development of fuel cells, and the U.S. Navy is supporting work on thermoelectric converters.

The simplest of all these systems—geothermal steam—also has the most immediate commercial possibilities. It is present in sufficient quantities to provide all the power mankind could use in thousands of years. Unfortunately, however, in most places the earth's crust is about 20 miles thick, and the steam therefore is generally inaccessible. It rises to the surface only through faults or cracks in the crust, to manifest itself as hot springs, geysers or volcanoes. By drilling wells along the fault lines, as has been done in Italy and New Zealand and perhaps elsewhere, one has been able to accelerate the flow of steam and obtain useful energy. An attempt was made in the early 'twenties to utilise the geothermal steam rising through a fault at a place called The Geysers, about 40 miles north of San Francisco. Six wells were drilled, of which four produced steam in usable quantities. Since the utility companies were not interested, the steam has been blowing off ever since. In the past three years, however, the Magma Power Company has brought in five additional wells, and the Pacific Gas and Electric Company has agreed to spend 2,000,000 dollars on a 12·5MW generating plant, to be completed next April.

In the realm of solar energy, many American companies have come up with commercial products designed to make use of this power. On the market are solar-activated watches and clocks, wireless sets, hearing aids, movie cameras and cigarette lighters. In Southern states, several firms are doing a brisk business in equipment for solar house heating, and others are making outdoor solar coolers. The most spectacular application of the sun's energy so far is in the 81·5 lb " paddle-wheel " " Explorer VI " satellite, in which solar cells generate power for transmitters to send information on cosmic radiation back to earth. The direct conversion of sunshine to electricity in solar batteries is accomplished by photovoltaic cells of silicon crystals, which are so expensive that they bring the cost of power thus generated to about 400 dollars per watt. Some hope is seen of reducing this cost through the use of gallium arsenide cells although, to date, the latter have proved only 5 per cent efficient in laboratory experiments, compared with up to 14 per cent efficiency with silicon. The most recent development in the field of solar energy is the ferro-electric converter. This uses a ceramic substance such as barium titanate sandwiched between charged metal plates. When the ceramic material is heated, by the sun's rays or any other source, it transfers electrical energy to the plates. Advantages of the system are that it can produce as much as 1000V, from a converter element the size of a sixpence, and that it can be arranged to produce alternating current.

New systems for converting heat into electricity are the subject of extensive research by a number of industrial firms, and some of these projects eventually may bring economical nuclear power a step nearer to reality. They seek to replace the steam turbo-generator, in which conversion efficiencies still are less than 40 per cent. In theory, at least, some of the new systems are capable of much higher efficiencies. One idea is to take advantage of the principle of thermionic emission. Only a few weeks ago, R.C.A. and the Thiokol Chemical Company announced the development of a thermionic power unit for rockets and jet aircraft which utilises heat from the exhaust. The companies believe it will produce 250W per square centimetre with an efficiency of 35 per cent. Of at least equal promise are thermoelectric generators utilising the Seebeck effect. The Minnesota Mining and Manufacturing Company has designed the " Snap III " generator which converts the natural heat of isotopes into electric power for space vehicles and generates 5·3W with an efficiency of 5·5 per cent. Westinghouse Electric recently completed a 100W thermoelectric generator for the U.S. Air Force, to be used on the ground as an auxiliary power source. Weighing only 40 lb, it operates on a gas flame at a temperature of 850 deg. Fah. Still another possibility for converting heat to electricity is through magneto-hydrodynamics (MHD). This method involves plasmas, or gases which have been heated to above 5000 deg. Fah. At such temperatures gases give off electrical energy when passed through a magnetic field. Thus they can be substituted for the armature in an ordinary generator. General Electric and the Avco Corporation both have built experimental MHD generators and report that efficiencies up to 65 per cent are possible. In conjunction with ten utility companies, Avco has set up a research programme which should result in a large-scale operating MHD power plant in ten to twenty years.

The greatest excitement of all has been sparked by the fuel cell. The basic principle on which fuel cells work is neither new nor very complicated. It is simply electrolysis in reverse. Instead of using electricity to break down water into its components, hydrogen and oxygen, one can feed the latter two gases into a cell continuously to produce water and electricity. Dr. F. T. Bacon designed a " hydrox " cell which achieves higher output by forcing the gases through the electrolyte under pressure and at temperatures of 400 deg. to 500 deg. Fah. Under licence from the British Government, the Leesona Corporation is now building Bacon cells for testing by the U.S. Army. Dr. Karl Fordesch of Union Carbide believes that, with liquid hydrogen soon to become available in commercial quantities at 1·50 dollars per pound, the Bacon cell will be competitive with diesel engines for locomotives. For space applications, General Electric has developed a saucer-sized " hydrox " cell in which a permeable membrane replaces the electrolyte. It can be used in conjunction with the photovoltaic solar battery for storage purposes. When the sun is shining on the satellite, some power from the solar batteries is fed to the cell, for reducing water to hydrogen and oxygen ; when the vehicle is in shadow, the cell converts the gas to water again and gives off electricity.

Probably the most promising approach to cheap power from fuel cells is the Carbox system, pioneered by H. H. Chambers of the Sondes Place Research Institute in Dorking. Carbox cells may operate on methane, propane, petrol or even kerosene. Again, the Leesona Corporation claims to have stolen a march on other American firms through a tentative licensing agreement, but several other American concerns are working on similar cells. Allis-Chalmers, in fact, recently unveiled an experimental tractor powered by 1008 fuel cells, using propane mixed with other unnamed gases and oxygen. Although the Allis-Chalmers cells have a low power-to-weight ratio, they operate at room temperature, whereas the Chambers cells, using molten salt as an electrolyte, require a considerable amount of thermal energy.

Stepwise Compaction Process for Ceramic and Metallic Powders

THE Materials Engineering Department of the Westinghouse Electric Corporation, East Pittsburgh, Pennsylvania, has developed an interesting process which, for the first time, makes it possible to construct large ceramic and metallic objects from tungsten, molybdenum and other high-strength, high-temperature materials. Until the discovery of the new Westinghouse process, attempts to prepare large bars, strips or sheets from powders were expensive, cumbersome and technically difficult to achieve. For this reason, only those small objects which can be pressed directly into their final exact shape have been made commercially from powders.

In the Westinghouse continuous compaction process, loose powder is placed in a trough and is then pressed with a punch, as illustrated. By a succession of pressing operations, a continuous bar or strip is produced. As shown in the accompanying diagram, powder under the sloping part of the punch is pressed with an infinite number of pressure values from zero to the maximum pressure under the horizontal surface. The punch is raised and the powder is moved forward. Vertical punch travel is arbitrary except that the punch should clear the loose powder on the next stroke. If the powder advance is not too great, some fully compacted powder still remains under the finishing area. Because it cannot be compacted any more, it shows no density discrepancies or surface marks. Powder under the sloping portion of the punch receives another increment of compaction during the next pressure stroke. By repetition of this cycle, loose powder is pressed into a continuous bar. The bar then can be sintered and further processed.

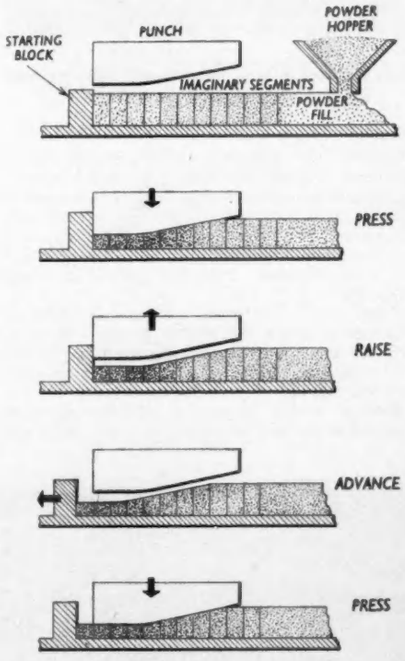


Fig. 1—Diagram of Westinghouse stepwise powder compaction process

Experiments indicate that the punch slope can vary with little effect on the compaction process. Low angles reduce process speed and efficiency, but might be desirable for pressing a small powder fill ; high angles displace the powder laterally, resulting in bar thickness variation. A proper balance must be established, depending upon the end requirement. Many cross-sectional shapes and sizes can be produced with the process. Only 1in and 2in channels have been produced so far, but there is no reason why wider bars cannot be pressed. The required capacity of the press, other conditions being equal, increases with the strip width. Thickness is not severely limited, although a practical limit will probably be encountered for any given press. Although bar thicknesses up to 1in have been produced with no difficulty, thicker pressings have not been attempted. The lower limit of thickness has not been established, but materials probably can be compacted into strip of five to ten thousandths of an inch.

The amount of advance per stroke can vary over a wide range. If it is too short, the operation will be inefficient, and if too long, a smooth bar cannot be obtained. The length of the punch finishing area is a design factor that can vary. It should be somewhat longer than the minimum advance per stroke, but it can be increased with no appreciable effect, except that a greater force is required for the initial pressing stroke.

Other powder metallurgy processes can either produce a thick bar with limited length, or long strips of small cross section. With the new process, the thickness of the bar is variable within wide limits. Thus, powder metallurgy techniques can now be used to advantage in many new applications. Multiple pressing action also can be envisioned, at least from the top pressing surface. Bars produced with this method are constant in cross section if the powder fill is maintained. Another important advantage is the consistency of the density that can be achieved over the length of the bar. The good quality of the surfaces, edges and corners is another advantage. An iron-clad copper bar has been produced with this process. One end of the bar is solid iron ; the copper centre starts midway and continues to the other end. This suggests many other interesting variations. An automatic set-up can be made, capable of producing bars of unlimited length that can be fed directly into a sintering furnace and then to further processing steps, such as rerolling. For experimental purposes, however, a simpler set-up was used to produce bars of limited length.

Fig. 2—Punch and die trough installed on press for stepwise compaction of powders, with resulting bar in foreground

Bars have been made from various commercial iron powders, including electrolytic iron, " RZ " iron, and Swedish sponge iron. In addition to pure metal powders, a variety of alloys have been pressed from elemental powder mixes. They include iron-nickel magnetic alloys, iron-silicon alloys and Kovar alloy (an iron-nickel-cobalt glass-sealing alloy). Titanium sponge, sponge-iron melting stock, columbium roundels, and tungsten and molybdenum powders have been made into electrodes for further melting. This compaction process might be used to fabricate large sizes of refractory metal sheet, strip or bar, such as tungsten, molybdenum and tantalum. The continuous fabrication of tungsten powder into filaments is also a possibility.

Precise composition can be maintained in the fabrication of sheet and strip alloys. Also, alloys too brittle for conventional methods of working can easily be worked after the continuous compaction process. The process can also make possible the low-cost fabrication of powder sponge and highly reactive metals and alloys. The metals can then be processed by sintering and working, or by vacuum-arc melting. This technique would enable high-purity, low-cost raw materials to be used, and would avoid problems such as excessive segregation. The single-step preparation of composite or clad bars, sheet and strip of different metals should also be possible, including thermal bimetals and bearing bimetals. When lower cost powder materials become available, this continuous compaction process may facilitate an economical large-scale production of common metals and alloys directly from powders.

Zone Melting of Boron

THE discovery at the Bell Telephone Laboratories of a method for pressing rods of commercially available powdered boron has led, in turn, to the successful floating zone melting of that extremely high-melting element. The technique will provide larger crystals for basic research studies of this semiconductor than have been available before.

Because of its physical properties, boron does not lend itself to floating zone melting, since it is not possible to form the powder into a suitable shape by pressure alone. The pressed forms are so friable that they crumble as soon as any attempt is made to remove them from the forming dies. In one version of the new technique, boron powder, −20 to 100 mesh in size, is placed in boiling boric acid solution, and the mixture is boiled to dryness. This coats the boron granules with boric acid, and the powder can then be pressed into forms which can be handled without breaking. The formed bars, or compacts, are heated in two stages under vacuum for one hour, at temperatures of 300 deg. to 600 deg. Cent. to decompose the boric acid into boron oxide. This compound forms a liquid coating on the boron particles. When the compact is cooled, this liquid hardens, and bonds the powder into a strong bar.

The bar of boron powder is mounted vertically for floating zone melting, and a high frequency induction coil is used to melt a narrow band or zone of the material. The molten zone is moved down the rod by raising the bar through the coil, while the melted boron freezes or crystallises above the coil. During this operation, the boron oxide binder sublimes before the melting point of boron, about 2000 deg. Cent., is reached. Crystals as large as 0·1in were obtained, many of which were twinned.

The apparatus used in the floating zone

THE AMERICAN SCENE *(Continued)*

Rod of boron powder undergoing floating zone melting

refining is similar to that used in the treatment of other materials, except that the rod of boron is enclosed within two concentric transparent quartz tubes. The inner tube is slotted ; when the subliming boron oxide coats the tubes enough to restrict vision, the slotted tube is rotated to give a clear field again. This modification to the equipment has previously been used in the floating zone melting of gallium arsenide at the Bell Laboratories. Preparatory to mounting the compact, the corners of the square bar are ground off, to minimise the " cage " effect, in which the corners do not melt. Also, in order to lower the resistivity of the boron, to allow it to be heated and melted by high-frequency induction, the top end of the bar is mounted in a graphite cup, which can be readily heated by such means.

Transfer Machine for Power Steering Pump Housings

TRANSFER machines are commonly thought of as performing only related operations. An " Economatic " transfer machine, designed and built with standard components by the Buhr Machine Tool Company, of Ann Arbor, Michigan, demonstrates, however, that many operations can be combined effectively. Installed at the Saginaw Steering Gear Division of the General Motors Corporation, Saginaw, Michigan, this seventy-six-station closed-loop pallet transfer machine (Fig. 1) includes drilling, reaming, tapping, recessing, face milling, wire brushing, surface generation, precision boring and assembly among its 220 operations. In addition, each power-steering pump housing is automatically gauged and marked so that it can be selectively assembled with mating components.

In this installation, two hydraulic pump housings are manually loaded and then automatically located and clamped in each fixture-pallet. The parts are finished at the rate of 300 per hour at 100 per cent efficiency. Fig. 2 is a front view of the pallet fixture, with two housings clamped in position, showing the spherically mounted " crows-feet " and the pivoted clamp that permit full equalisation of clamping forces. The lubricant injector, slightly below centre, is automatically coupled to the lubricant supply after each circuit of the machine. Steps under each workpiece align the hand gauges employed. Various surfaces are milled and some holes are drilled, reamed, spot-faced, counterbored, chamfered and tapped. Near the end of the first 117ft long leg of the machine, a babbitt bushing is correctly oriented with respect to the pump-shaft hole and is then pressed home. The inside diameter of these bushings are precision-bored after assembly. At one station an air gauge scans the precision-bored pump-plunger hole for size and roundness. The classifier then automatically sprays the pump housing with a small spot of paint of the appropriate colour to indicate the relation of the gauge reading to the specified tolerance range. At light-machining stations, the workpieces are flooded with soluble oil coolant to remove chips. After the last machining station, the parts are run through an air-blow booth to remove the chips remaining in deep holes and on the fixture. Just before the pallet fixtures are indexed to the unload station, the fixture clamp is automatically backed off and rotated 90 deg. so that the operator can easily unload the parts.

Transfer machines of this type are versatile because different operations can be combined in them and because they can be re-arranged to profit from experience gained during production. During try-out of this machine, for example, it was found that the critical pump-body face was produced to the close print tolerances for flatness by the single-point surface-generating tool. There was no need for the subsequent burnishing operation originally included in the process. The burnishing operation has been dropped and, after shifting units and operations at two other stations, it has been possible to add a new operation that was to have been done as a secondary operation. The added operation involves " ballising " a hole to size and to required surface finish.

Another example of process freedom in this installation is found at the face milling station. The face mill is hydraulically fed into the pump housing and mills on an upward feed stroke of the cutter. Change gears have been included in these heads so that the right feed and cutting speed may be selected for optimum cutter life. The ability to vary the spindle speed provides flexibility for workpiece material changes in the future. The precision-boring operations require almost twice as much time as any other machining operation on this twenty-four-second cycle machine. Rather than double the cycle time, pallets are accumulated and then indexed two at a time through the two precision-boring stations.

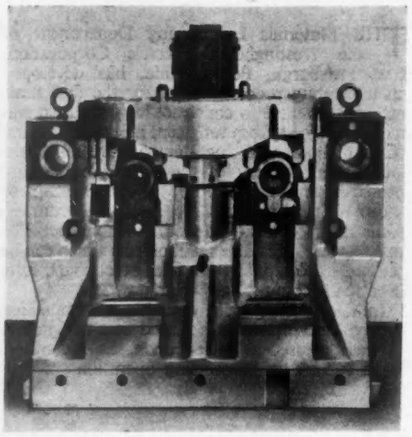


Fig. 2—Front view of pallet fixture with two pump housings clamped in position

Automatic in-process checking is done at various stations by twelve probes, to make certain that all holes have been drilled, and by thirteen drill checks to monitor the condition of other drills. In addition to automatic classification, roving inspectors occasionally check partially finished workpieces when the pallet fixtures are in idle stations. With dial-indicator gauges, they can check the housing from both sides of the line. Gauge locating steps and buttons are included in the pallet fixture to reduce the time required for these inspections. As a safety measure, however, the inspector actuates a selector switch at the station to prevent the operator from indexing the transfer mechanism. When the inspector has checked the workpiece, he shifts the selector switch so that the machine can again cycle.

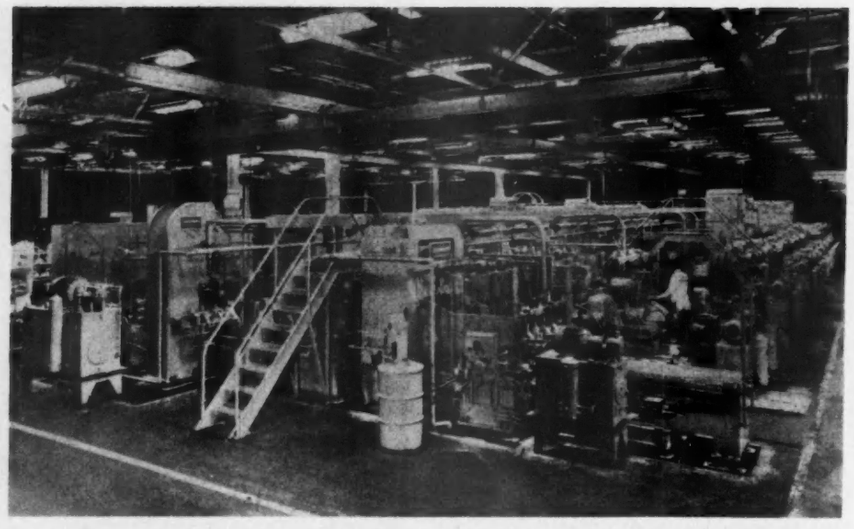


Fig. 1—Seventy-six-station " Economatic " closed-loop pallet transfer machine for the production of power-steering pump housings

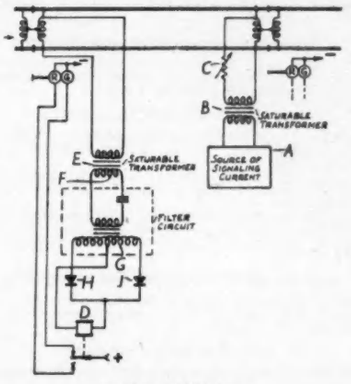
BRITISH PATENT SPECIFICATIONS

The dates printed are those of application and publication on completion. Copies of specifications may be obtained at the Patent Office Sales Branch, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each.

RAILWAY SIGNALLING

826,553. November 3, 1955.—A.C. TRACK CIRCUITS FOR RAILWAY SIGNALLING, Westinghouse Brake and Signal Company, Ltd., Harry Duckitt and Peter Tillotson, all of 82, York Way, King's Cross, London, N.1.

Where a.c. traction is employed, it has been proposed to choose for the track circuits a signalling current of a different frequency from that of the traction current and to provide filter circuits tuned to pass only current of the chosen frequency, which is rectified and supplied to a d.c. track relay. It has been found, however, that under certain fault conditions the voltage of traction current frequency which appears across the track rails at the relay end of the track section rises to a value at which the filter circuit passes sufficient current of that frequency to sustain energisation of the track relay when a vehicle enters the track section. According to this invention, faulty energisation is prevented by the use of a saturable transformer, one method of application being shown in the drawing. Each track circuit



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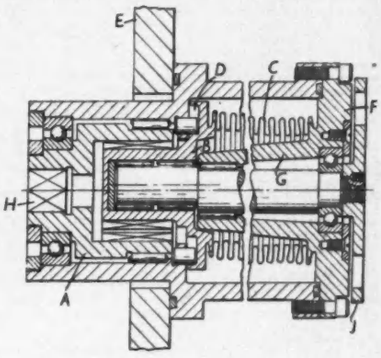
comprises a source of signalling current *A* which is connected through a saturable transformer *B* and feed resistor *C* to the rails at one end of the track section. The frequency of the traction current may be 50 c/s and the frequency of the signalling current may be 75 c/s. The track circuit also includes a d.c. track relay *D* for each track section, connected to the rails by means comprising a saturable transformer *E* with a secondary winding *F* connected to a filter circuit *G* adjusted to resonate at the signalling current frequency. In operation, the filter circuit passes current of the signalling frequency with little or no attenuation but presents a high attenuation to the traction current. The inductance associated with the filter circuit has a centre-tapped secondary winding *G* connected through a full-wave rectifying circuit comprising rectifiers *H*, *J* to the track relay *D*. Normally the filter circuit passes enough current of the signalling frequency to energise the relay, but the saturable transformer is designed so as to become saturated with the lowest voltage of traction current frequency compatible with normal operation of the track circuit at signalling current frequency. The specification also describes an alternative two-stage filter circuit and applications of the invention to coded track circuits.—*January* 13, 1960.

POWER TRANSMISSION

826,513. February 21, 1958.—GLANDLESS SHAFT DRIVE TRANSMISSION SYSTEMS, United Kingdom Atomic Energy Authority, London. (*Inventor : George Oliver Jackson.*)

This invention relates to devices allowing rotary motion to be transmitted through the wall of a closed vessel without the use of a gland. The glandless shaft drive comprises a casing having inside it the gear wheel *A* free to rotate about a fixed axis, and a second gear wheel *B* having its axis free to move in a circular path whilst being restricted from rotating relative to the casing. The wheel *B* meshes internally with the wheel *A* and is sealed in a flexible bellows *C* so that with the bellows it forms a complete seal. The wheel *B* is mounted on a crank part of a driving shaft and has four equally spaced recesses *D*. Four pegs extending into the recesses are located in the casing and are arranged so that each one is in contact with the wall of its recess for all positions of the gear wheel *B*. Thus, with the crank in its highest position, as shown in the drawing, the pegs are in contact with the lowest portions of the walls of the recesses. The recesses are larger in diameter than the pegs by an amount equal to twice the throw of the crank. The casing is mounted in an access hole in a vessel wall *E* by a sealing flange. The casing has an end plate *F* with a flange to which is sealed the other end of the bellows *C*. The end plate also has



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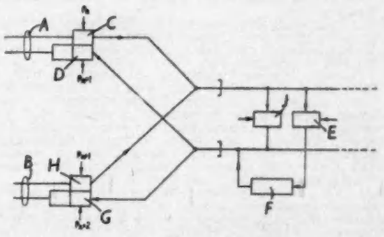
a tubular bearing support *G* in which the shaft is located by a ball race and a roller race. The gear wheel *A* is located in the casing by a ball race and a roller race, and it has a recess *H* into which can be coupled a driven member. In operation drive is transmitted to the crank through the drive shaft coupling plate *J*. As the crank rotates, the gear wheel *B* moves round the inside of the annulus. Since the pegs are in contact with the walls of the recesses in all positions of the wheel *B* the wheel is restricted from rotating relative to the casing and hence the drive is transmitted to the gear wheel *A*. The bellows is stressed only by reason of its deflection as the wheel *B* moves, the torque between the shaft and the wheel *A* being taken completely at the teeth. In the system described above the wheel *B* has twenty teeth and the gear wheel *A* twenty-three giving a gear ratio of 23 : 3. The system is typically operated at an output torque of 100 lb-ft.—*January* 13, 1960.

TELECOMMUNICATIONS

826,631. June 12, 1953.—TIME DIVISION MULTIPLEX COMMUNICATION SYSTEMS, H.M. Postmaster General, of the General Post Office, London, E.C.1. (*Inventors : John Edward Flood and Lionel Roy Frank Harris.*)

This invention relates to time division multiplex communication systems and has particular, although not exclusive, reference to automatic electronic telephone exchange systems employing time division multiplex for the purposes of selecting circuits, switching connections between circuits and trans-



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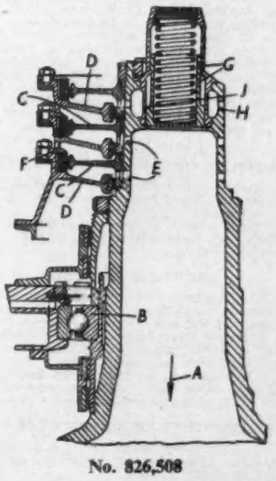
mitting signals such as speech. Where numbers of circuits are connected to common bothway transmission paths, a link between two particular circuits of different groups may be established by the application of pulse trains to transmit and receive modulators. Considering the drawing, if the transmitter of circuit *A* is to be connected to the receiver of circuit *B*, it is necessary to prevent pulses from the transmit modulator *C* from being received back over receive modulator *D*. A pulse train *Pn* is applied to *C* and intermediate modulator *E*, and communication with receive modulator *G* will be established if the latter has applied to it a pulse train coincident with the pulse train emerging from delay device *F*. Let this be *Pn*+2. A pulse train other than *Pn* must be made effective in receive modulator *D*, and such a train, having a delay *Pn*+1, may be derived by passing the train *Pn* through a time delay network. To establish communication in the reverse direction, between receive modulator *D* and transmit modulator *H*, it is necesary to make effective in *H* and intermediate modulator *J* a pulse train coincident with *Pn*+1. If this is done it will be seen that pulse train *Pn*+2 made effective in *G* is a delayed version of pulse train *Pn*+1 made effective in *H* and thus can be derived from it.—*January* 13, 1960.

GAS TURBINES

826,508. December 23, 1957.—ROTOR THRUST REDUCING MEANS FOR A GAS TURBINE, Armstrong Siddeley Motors, Ltd., Coventry, Warwickshire. (*Inventor : Horace Sinclair Rainbow.*)

The invention relates to an axial flow gas turbine plant having a compressor and turbine rotor assembly associated with a thrust bearing which is subjected to the difference between the oppositely-acting thrusts of the rotors during operation. The thrust of the compressor rotor is usually the larger. It is known to reduce the value of this difference in thrusts to a degree acceptable to the thrust bearing by using a peripherally-sealed disc (commonly called a "thrust piston") mounted on the rotor assembly adjacent the last stage of the compressor rotor. According to the invention, instead of a single large thrust piston, use is made of a number of coaxial thrust pistons spaced along the rotor assembly and co-acting with associated stationary reaction pistons. Upon the rotor shaft extension, the thrust due to the compressor rotor, being greater than that due to the turbine rotor, will result in a preponderance of thrust, indicated by the arrow *A*



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acting on the bearing assembly *B*. In accordance with the invention, use is made of axially-spaced thrust pistons *C* (three of which are shown) made fast with the shaft, and of intercalating, reaction pistons *D* fixed on a stationary structure. The shaft extension is hollow and connected to receive air from the compressor at the output pressure. This air pressure is communicated through lateral ducts *E* to working chambers between each reaction piston and the thrust piston above it. The spaces between each thrust piston and the reaction piston next above it are vented to atmosphere through ports *F*. As the compressor rotor thrust increases with compressor output pressure, increased air pressure is admitted through the ducts *E* to act on the thrust pistons *C* to urge the extension in the direction for reducing the thrust on the bearing assembly *B*. Normally the uppermost ducts *E* in the extension are masked by a piston valve member *G* which is normally biased by a spring. When the compressor output pressure rises above a predetermined value the valve is raised against the spring load to uncover a port which communicates with the ducts *H* and thus add the effort of the uppermost working chamber for reducing the thrust on the bearing. When the compressor output pressure again falls below the predetermined value, the spring moves the valve to isolate the port *J* and thus reduce the counter-thrust. *January* 13, 1960.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

Mon., Feb. 15.—BRISTOL AND WEST OF ENGLAND BRANCH: Grand Hotel, Bristol, "Port Electrical Installations," S. Evans, 8 p.m.

Tues., Feb. 16.—ALDERSHOT AND DISTRICTS BRANCH: Queens Hotel, South Farnborough, Hants, "Safety and the Supervisor," H. E. M. Thomas, 7.30 p.m. ★ LONDON NATIONAL LECTURE: Manson House, 26, Portland Place, London, W.1, "Current Practices and Recent Trends in Cable Joints and Terminations," H. Flack, 6.30 p.m. ★ OXFORD AND DISTRICTS BRANCH: Employment Exchange, Oxford, "Radio Astronomy," A. D. Petford, 8 p.m.

Wed., Feb. 17.—NOTTINGHAM BRANCH: E.M.E.B. Showroom Theatre, Carrington Street, Nottingham, "Automatic Fuel Control," S. F. Snowdon, 7.30 p.m. ★ WOLVERHAMPTON AND DISTRICT BRANCH: Chamber of Commerce, District Bank Chambers, Lichfield Street, Wolverhampton, "Fire Prevention in Industry," M. Gee, 7.45 p.m.

Fri., Feb. 19.—STOKE AND CREWE BRANCH: Grand Hotel, Hanley, Films Night, 7.30 p.m.

BRITISH COMPUTER SOCIETY

Thurs., Feb. 18.—LONDON BRANCH: Northampton College of Advanced Technology, St. John Street, London, E.C.1, "The Development of the Use of a Computer for Production Control," R. G. Hitchcock, 6.15 p.m.

BRITISH INSTITUTE OF MANAGEMENT

Thurs., Feb. 18.—Recital Room, Royal Festival Hall, London, S.E.1, One-day conference "Drawing Office Management," 9.30 p.m.

BUILDING CENTRE

Wed., Feb. 17.—Lecture Room, 26, Store Street, London, W.C.1, Forum, "Factory Flooring," 6 p.m.

COMBUSTION ENGINEERING ASSOCIATION

Thurs., Feb. 18.—NORTHERN REGION: George Hotel, St. George's Square, Huddersfield, Discussion on "The Workings of the Clean Air Act," 2.30 p.m.

DIESEL ENGINEERS AND USERS ASSOCIATION

Thurs., Feb. 18.—Institute of Marine Engineers, Memorial Building, 76, Mark Lane, London, E.C.3, "Foundations and Mountings for Diesel Engines," P. J. C. Teece, 2.30 p.m.

ILLUMINATING ENGINEERING SOCIETY

Tues., Feb. 16.—LIVERPOOL CENTRE: Merseyside and N. Wales Electricity Board Industrial Development Centre, Liverpool, "Light and Horticulture," A. E. Canham, 6 p.m.

Mon., Feb. 22.—BIRMINGHAM CENTRE: Regent House, St. Philip's Place, Colmore Row, Birmingham, Annual General Meeting and Symposium, 6 p.m. ★ LEEDS CENTRE: British Lighting Council, 24, Aire Street, Leeds, 1, "The Design and Manufacture of Neon Signs," A. Urquhart, 6.15 p.m. ★ LEICESTER CENTRE: Demonstration Theatre, East Midlands Electricity Board, Charles Street, Leicester, "Practical Aspects of Neon and other Luminous Signs," T. Coates, 7 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN

Mon., Feb. 15.—EAST ANGLIAN SECTION: Lecture Hall, Public Library, Ipswich, Short Paper Competition for the L. J. Tibbenham Award, 7.30 p.m.

Tues., Feb. 16.—SLOUGH SECTION: Lecture Theatre, High Duty Alloys, Ltd., Slough, Brains Trust, "Quality in Pressure Diecasting," 7.30 p.m.

INSTITUTE OF FUEL

Wed., Feb. 17.—YORKSHIRE SECTION: Metropole Hotel, Leeds, "Developments in I.C. Engine Fuels," W. S. Ault, 2.30 p.m. ★ REPUBLIC OF IRELAND GROUP: Engineers' Hall, 35, Dawson Street, Dublin, "Liquid Fuel for High Temperature Furnaces," A. B. Pritchard and J. A. Taylor, 8 p.m.

Thurs., Feb. 18.—NORTH-WESTERN SECTION: Blossoms Hotel, Chester, "Problems with the Use of High Sulphur Oil Fuels at Marchwood Power Station and Experience with Chemical Additives," T. J. Wilkinson and D. Clarke, 7.30 p.m.

INSTITUTE OF NAVIGATION

Fri., Feb. 19.—Royal Geographical Society, 1, Kensington Gore, London, S.W.7, Discussion on "Space Navigation," introduced by J. G. Porter, 5.15 p.m.

INSTITUTE OF ROAD TRANSPORT ENGINEERS

To-day, Feb. 12.—SOUTH WALES CENTRE: South Wales Institute of Engineers, Park Place, Cardiff, "Transport Developments in U.S.A., 1957," John F. Moon, 7.15 p.m.

Mon., Feb. 15.—EAST REGIONAL CENTRE: Council Chamber, Houldsworth Hall, 90, Deansgate, Manchester, "Wear and Tear (Part 2)," J. E. Johnson, 7.30 p.m. ★ SCOTTISH CENTRE: North British Hotel, Princes Street, Edinburgh, "Vehicle Maintenance—by Control Board," J. McCall, 7.30 p.m.

Tues., Feb. 16.—EASTERN CENTRE: Refectory, Peterscourt Office, F. Perkins, Ltd., Peterborough, "The Future of Road Transport," A. Enticknap, 7 p.m. ★ NORTH EASTERN CENTRE: Three Tuns Hotel, Durham City, "Unusual Types of Trailer Suspension including Air Suspension," J. L. B. Crane, 7.30 p.m.

Thurs., Feb. 18.—METROPOLITAN AREA: Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2, "Wear and Tear (Part 2)," J. E. Johnson, 6.30 p.m. ★ YORKSHIRE CENTRE: Mechanics' Institute, Nottingham, "Is Lubrication Necessary," R. C. Nicholls, 7.30 p.m.

INSTITUTE OF WELDING

Wed., Feb. 17.—NORTH AND SOUTH LONDON BRANCHES: 54, Princes Gate, London, S.W.7, Joint meeting, "High Pressure Pipelines in the Gas Industry," F. W. Bell, 7.30 p.m.

INSTITUTION OF AGRICULTURAL ENGINEERS

Mon., Feb. 15.—NORTHERN CENTRE: North-Eastern Electricity Board's Lecture Theatre, Carliol House, Newcastle upon Tyne, "Agricultural Aviation with particular Reference to Aerial Spraying," D. B. Blackett, 6.45 p.m.

INSTITUTION OF CIVIL ENGINEERS

Tues., Feb. 16.—Great George Street, Westminster, London, S.W.1, "The Design and Construction of the Queen Elizabeth Graving Dock at Falmouth," A. E. Underwood, J. D. Norfolk and J. W. Eathorne, 5.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

To-day, Feb. 12.—NORTH SCOTLAND SUB-CENTRE: Robert Gordon's Technical College, Aberdeen, "The Design and Performance of the Gas-Filled Cable System" E. P. G. Thornton and D. H. Booth, 7.30 p.m. ★ NORTH STAFFORDSHIRE SUB-CENTRE: Technical College, Stoke-on-Trent, "The Provision of Adequate Electrical Installations in Buildings—Multi-Storey Flats and Maisonettes," C. A. Belcher and "Houses," C. C. Hyams, 7 p.m.

Mon., Feb. 15.—LONDON GRADUATE AND STUDENT SECTION: Savoy Place, London, W.C.2, "Inertial Navigation Systems," E. W. Anderson, 6.30 p.m. ★ MERSEY AND NORTH WALES CENTRE: Donnan Laboratories, Vine Street, Liverpool, Second Hunter Memorial Lecture, "The Protection of Electrical Systems," H. G. Bell, 6.30 p.m. ★ NORTH-EASTERN MEASUREMENT AND ELECTRONICS GROUP: Rutherford College of Technology, Newcastle upon Tyne, "Progress in Permanent Magnetic Materials," J. E. Gould, 6.15 p.m. ★ SHEFFIELD SUB-CENTRE: Angel Hotel, Brigg, "D.C. Winder Drives using Mercury Arc Rectifier/Inverters," L. Abram, J. P. McBreen and J. Sherlock, 6.45 p.m.

Tues., Feb. 16.—MEASUREMENT AND CONTROL SECTION: Savoy Place, London, W.C.2, Discussion on "Soviet Control Engineering Progress," opened by R. E. Clark, 5.30 p.m. ★ EAST MIDLAND CENTRE: E.M.E.B. Centre, Charles Street, Leicester, "Electrification of the U.K.A.E.A. Industrial Group Factories," J. W. Binns and W. J. Outram, 6.30 p.m. ★ NORTH MIDLAND UTILIZATION GROUP: Leeds and County Conservative Club, South Parade, Leeds 1, "The Design of Electromagnetic Pumps for Liquid Metals," D. A. Watt, 6.30 p.m. ★ NORTH-WESTERN MEASUREMENT AND CONTROL GROUP: Engineers' Club, Albert Square, Manchester, "Transistors—their Theory, Manufacture and Application," R. W. A. Scarr, 6.15 p.m. ★ SOUTH-EAST SCOTLAND SUB-CENTRE: Carlton Hotel, North Bridge, Edinburgh, "Assessment of Speech Communication Links," D. L. Richards and J. Swaffield, 7 p.m. ★ WESTERN SUPPLY GROUP: Demonstration Theatre, Electricity House, Colston Avenue, Bristol, 1, "Operation of Large Electrical Supply Systems," L. B. Law, 6 p.m.

Wed., Feb. 17.—FARADAY LECTURE: Central Hall, Westminster, London, S.W.1, "Electrical Machines," M. G. Say, 6 p.m. ★ LONDON GRADUATE AND STUDENT SECTION: Visit to Fuller Electric, Ltd., Walthamstow, 2 p.m. ★ SHEFFIELD SUB-CENTRE: Grand Hotel, Sheffield, "Engineering Education at the Technical Universities in Western Germany," D. B. Welbourn, D. B. Spalding and G. L. Ashdown, 6.30 p.m. ★ SOUTH-WEST SCOTLAND SUB-CENTRE: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, C.2, "Survey of Stereophony," T. Somerville, 6 p.m. ★ RUGBY SUB-CENTRE: College of Technology, Rugby, "Progress in Permanent Magnet Materials," J. E. Gould, 6.30 p.m.

Thurs., Feb. 18.—UTILIZATION SECTION: Savoy Place, London, W.C.2, "Electricity in the Manufacture of Hydrogen Peroxide," B. E. A. Vigers and R. O. Fletcher, 5.30 p.m. ★ SOUTH-WESTERN SUB-CENTRE: Electric Hall, Torquay, "The Provision of Adequate Electrical Installations in Houses," C. C. Hyams, 3 p.m. ★ IRISH BRANCH: Physical Laboratory, Trinity College, Dublin, "Television Systems," H. De Lacy, 6 p.m.

Sat., Feb. 20.—LONDON GRADUATE AND STUDENT SECTION: Visit to Houses of Parliament (Plant Rooms and Technical Services), 10.30 a.m.

INSTITUTION OF ENGINEERING DESIGNERS

Wed., Feb. 17.—YORKSHIRE BRANCH: Midland Hotel, Bradford, Annual General Meeting, 7.30 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND

Tues., Feb. 16.—39, Elmbank Crescent, Glasgow, "Vibration Problems in Marine Machinery and their Solution," W. McLaughlin, 6.30 p.m.

INSTITUTION OF HIGHWAY ENGINEERS

Fri., Feb. 19.—NORTH-EAST BRANCH: Municipal Buildings, Middlesbrough, "The Design and Installation of Corrugated Metal Structures," P. R. S. Holmstrom, 7 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS

Tues., Feb. 16.—Institution of Mechanical Engineers, 1, Birdcage Walk, Westminster, London, S.W.1, "Trends in Transmission Design for Self-Propelled Diesel Railcars," A. Gordon Wilson, 5.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

Sat., Feb. 13.—LONDON GRADUATES' SECTION: 1, Birdcage Walk, Westminster, London, S.W.1, Biennial Conversazione, 7 p.m.

Mon., Feb. 15.—N.E. BRANCH: Cleveland Scientific and Technical Institute, Corporation Road, Middlesbrough, "Ashford Common Works of the Metropolitan Water Board with Special Reference to the Pumping Plant," F. Wood, 6.15 p.m. ★ DERBY AUTOMOBILE DIVISION: Midland Hotel, Derby, "Automobile Steering, Suspension and Tyres," D. Bastow, 7.15 p.m. ★ SCOTTISH AUTOMOBILE DIVISION: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, "Recent Developments in Journal Bearings," R. J. Welsh, 7.30 p.m. ★ MIDLAND GRADUATES' SECTION: Exchange and Engineering Centre, Stephenson Place, Birmingham, "Engineering Insurance and the Engineer," B. Chellingworth, 7 p.m.

Tues., Feb. 16.—N. IRELAND BRANCH: Kerr Room, Kensington Hotel, Belfast, "Some Thermal Aspects of Nuclear Reactors," J. McIlwaine, 7 p.m. ★ S. WALES BRANCH: S. Wales Institute of Engineers, Park Place, Cardiff, Annual Meeting, "Domestic Heating Installations and Appliances," W. H. Tarn and T. E. Tyrrell, 6 p.m. ★ N.W. AUTOMOBILE DIVISION: Engineers' Club, Albert Square, Manchester, "Lubrication of Automotive Wormgears," J. Whittle, 7.15 p.m. ★ COVENTRY GRADUATES SECTION: Craven Arms, High Street, Coventry "The Future Design Requirements of High-speed Motor Cycles" G. B. Spence, 7.30 p.m. ★ SOUTHERN GRADUATES' SECTION: Grand Hotel, Bournemouth, "Interplanetary Flight," L. R. Shepard, 7.30 p.m.

Wed., Feb. 17.—AUTOMOBILE DIVISION: 1, Birdcage Walk, Westminster, London, S.W.1, "Electrical Equipment of the Automobile," E. A. Watson, 6 p.m. ★ E. MIDLANDS BRANCH: Room C4, Engineering Building, University of Nottingham, "Industrial Control Systems," D. R. Hardy, 7.15 p.m. ★ N.E. AUTOMOBILE DIVISION: The University, Leeds, 2, "Vehicle Headlamp Beam Control," K. R. Jones, "Measurement of Driver Visibility and its Application to a Visibility Standard," R. A. C. Fosberry, 7.30 p.m. ★ N.E. GRADUATES' SECTION: Room A120, Rutherford College, Newcastle upon Tyne, "Lubrication of Internal Combustion Engines for Minimum Wear," H. Middleditch, 6.30 p.m. ★ S. WALES GRADUATES' SECTION: Park Hotel, Cardiff, Annual Meeting and Films, 6.30 p.m. ★ SOUTHERN GRADUATES' SECTION: Technical College, Guildford, Film Show, 7 p.m.

Thurs., Feb. 18.—EASTERN BRANCH: Technical College, Harlow, "Years of Development," R. A. Wilson-Jones, 7.30 p.m. ★ MIDLAND BRANCH: James Watt Memorial Institute, Great Charles Street, Birmingham, "The Effect of Nuclear Radiation on Engineering Materials," A. H. Cottrell, 6 p.m. ★ N.E. BRANCH: Stephenson Building, Claremont Road, Newcastle upon Tyne, Informal discussion on the paper "Mechanical Marshalling of Railway Wagons in Works Sidings," G. W. Grossmith, 6.15 p.m. ★ YORKSHIRE GRADUATES' SECTION: Hotel Metropole, Leeds, "Sheet Metal Working," N. S. Bailey, 6.30 p.m.

Fri., Feb. 19.—YORKSHIRE GRADUATES' SECTION: Royal Station Hotel, Hull, "What Do You Know About Patents?" T. A. Hulse, 7 p.m.

INSTITUTION OF PLANT ENGINEERS

Wed., Feb. 17.—KENT BRANCH: Queen's Head Hotel, Maidstone, "Fire Protection of Industrial Premises," F. Wain, 7 p.m.

Thurs., Feb. 18.—BLACKBURN BRANCH: Castle Hotel, Blackburn, "Some Experiences with Chemical Engineering Plant," J. C. Veale, 7.30 p.m. ★ MERSEYSIDE AND NORTH WALES BRANCH: The Blossoms, Chester, "Industrial Lighting in Factories," A. Wilcox, 7.15 p.m.

INSTITUTION OF PUBLIC HEALTH ENGINEERS

Thurs., Feb. 18.—Caxton Hall, London, S.W.1, "Water-Weed and Water Management," D. F. Westlake, 6 p.m.

JUNIOR INSTITUTION OF ENGINEERS

To-day, Feb. 12.—NORTH WESTERN SECTION: Engineers' Club, Albert Square, Manchester, "Cosmic Rays." Mr. Wolfendale, Jnr., 7.30 p.m. ★ LONDON SECTION: Pepys House, 14, Rochester Row, London, S.W.1, "Adhesion between Wheel and Rail," F. T. Barwell, 7 p.m.

Fri., Feb. 19.—Pepys House, 14, Rochester Row, London, S.W.1, "The Design Features of Large Radio Telescopes," J. Heywood, 7 p.m.

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS

To-day, Feb. 12.—Lecture Theatre, Mining Institute, Neville Hall, Newcastle upon Tyne, "Wind Tunnel Tests on Models of Merchant Ships," K. D. A. Shearer, and W. M. Lynn, 6.15 p.m.

PLASTICS INSTITUTE

Wed., Feb. 17.—WESTERN SECTION: Technical College, Gloucester, "The New Plastics: Recent Developments in Materials," C. W. Welch, 7 p.m. ★ SCOTTISH SECTION: North British Hotel, Edinburgh, "Plastics and Rubber in the United States," G. H. Madge, 7.30 p.m.

Fri., Feb. 19.—MIDLANDS SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham, 3, "Polyacetal Resin," 6.30 p.m.

REINFORCED CONCRETE ASSOCIATION

Wed., Feb. 17.—11, Upper Belgrave Street, London, S.W.1, "Lightweight Concrete with Sintered Clay Aggregate," R. H. Evans and T. R. Hardwick, 6 p.m.

ROYAL AERONAUTICAL SOCIETY

To-day, Feb. 12.—AGRICULTURAL AVIATION GROUP: 4, Hamilton Place, London, W.1, "Choice of Aerial Vehicle," F. R. J. Britten, and D. F. Myres, 7 p.m.

Wed., Feb. 17.—BRISTOL BRANCH: Conference Room, Bristol Aircraft, Ltd., Filton House, Bristol, "Firestreak," G. H. F. Brown, 6 p.m.

Thurs., Feb. 18.—ASTRONAUTICS AND GUIDED FLIGHT SECTION: Institution of Mechanical Engineers, 1, Birdcage Walk, Westminster, London, S.W.1, "Missile Control Problems," D. Best, 6 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN

To-day, Feb. 12.—21, Albemarle Street, London, W.1, "Fuel Cells: Will They Soon Become Major Sources of Electrical Energy?" F. T. Bacon, 9 p.m.

ROYAL SOCIETY OF ARTS

Mon., Feb. 15.—CANTOR LECTURE: John Adam Street, Adelphi, London, W.C.2, "The Fuel and Power Industries and National Prosperity—World and National Energy Resources," A. Parker, 6 p.m.

ROYAL STATISTICAL SOCIETY

Tues., Feb. 16.—EDINBURGH GROUP: Chamber of Commerce, 25, Charlotte Square, Edinburgh, "Industrial Applications of Time Series," G. A. Barnard, 7.30 p.m.

Wed., Feb. 17.—NORTH-EASTERN GROUP: Room C.39, Percy Building, King's College, Newcastle upon Tyne, 1, "Industrial Applications of Time Series," G. A. Barnard, 7 p.m.

Thurs., Feb. 18.—GLASGOW GROUP: Royal College of Science and Technology, Glasgow, C.1, "Stock Control," J. Battersby, 7.15 p.m.

SOCIETY OF CHEMICAL INDUSTRY

Wed., Feb. 17.—CORROSION GROUP: 14, Belgrave Square, London, S.W.1, "Adsorption on Electrodes and its Relation to the Rate of Electrode Processes," R. Parsons, 6 p.m.

SOUTH WALES INSTITUTE OF ENGINEERS

Thurs., Feb. 18.—22ND WILLIAM MENELAUS MEMORIAL LECTURE: Park Place, Cardiff, "Nuclear Energy from Fission and Fusion Reactions," Thomas E. Allibone, 6 p.m.

STANDARD ENGINEERS SOCIETY

Wed., Feb. 17.—UNITED KINGDOM SECTION: British Standards House, Park Street, London, W.1, "Putting Standards to Work," F. Butcher, 4.30 p.m.

WEST OF SCOTLAND IRON AND STEEL INSTITUTE

Fri., Feb. 19.—39, Elmbank Crescent, Glasgow, "Application of Electron Microscopy in Steel Research," F. B. Pickering, 6.45 p.m.

Advanced Engineering Courses

O.E.E.C. Courses on Nuclear Energy for Engineers and Technical Industrialists. Two international courses arranged by the European Nuclear Energy Agency of the O.E.E.C. One course will be at the Centre d'Etudes Nucléaires at Saclay, France, and the other at the Atomic Energy Research Establishment, Harwell. Each course will be open to some fifty participants from O.E.E.C. countries, and will cover the technical, economic and industrial aspects of nuclear energy. The course at Saclay (French language) will take place from June 27 to July 8; the Harwell course, in English, from July 4 to 15. Further information can be obtained from O.E.E.C. European Nuclear Energy Agency, 38, Boulevard Suchet, Paris, 16e.

Secondary Surfaces for Heat Exchangers. NORTHAMPTON COLLEGE OF ADVANCED TECHNOLOGY, St. John Street, London, E.C.1. A course of six lectures for students who are graduates in science or engineering or those with equivalent qualifications. Students will be expected to have a good knowledge of heat transfer. Wednesday evenings at 7 p.m., commencing March 2. Fee £1 1s.

Refresher Courses for Older Graduates. DEPARTMENT OF METALLURGY, BATTERSEA COLLEGE OF TECHNOLOGY, London, S.W.11. Three- to four-day courses by members of the College staff and visiting lecturers. "The Structure of Metals and Alloys," Easter vacation, April; "Developments in Foundry Practice," Summer vacation, July; "Austenite Transformation—The Present Position," Summer vacation, September.

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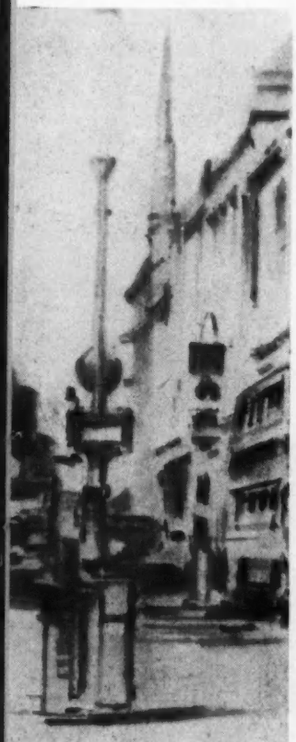

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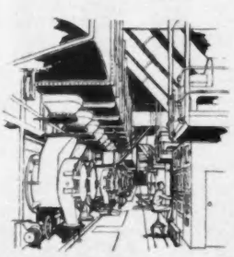

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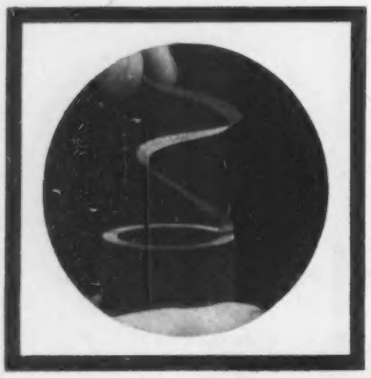

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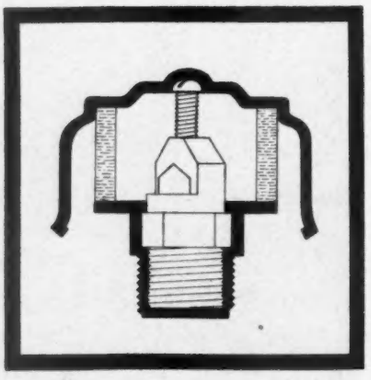

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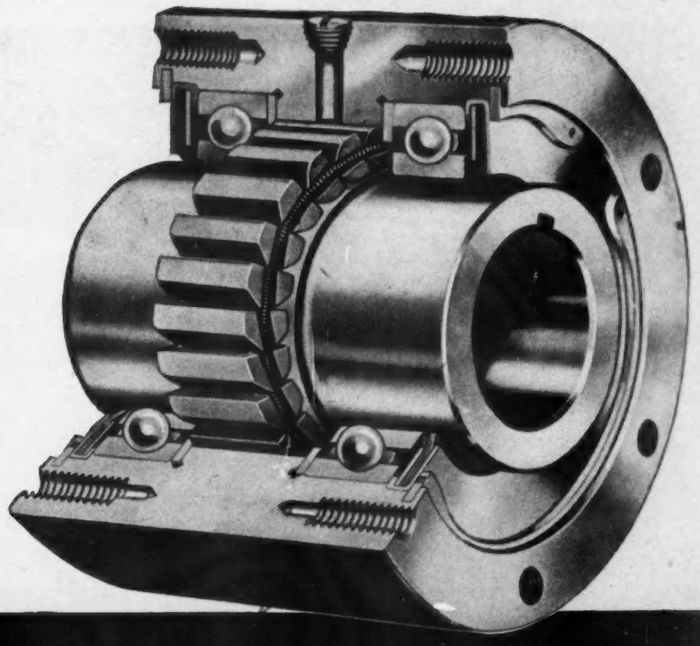

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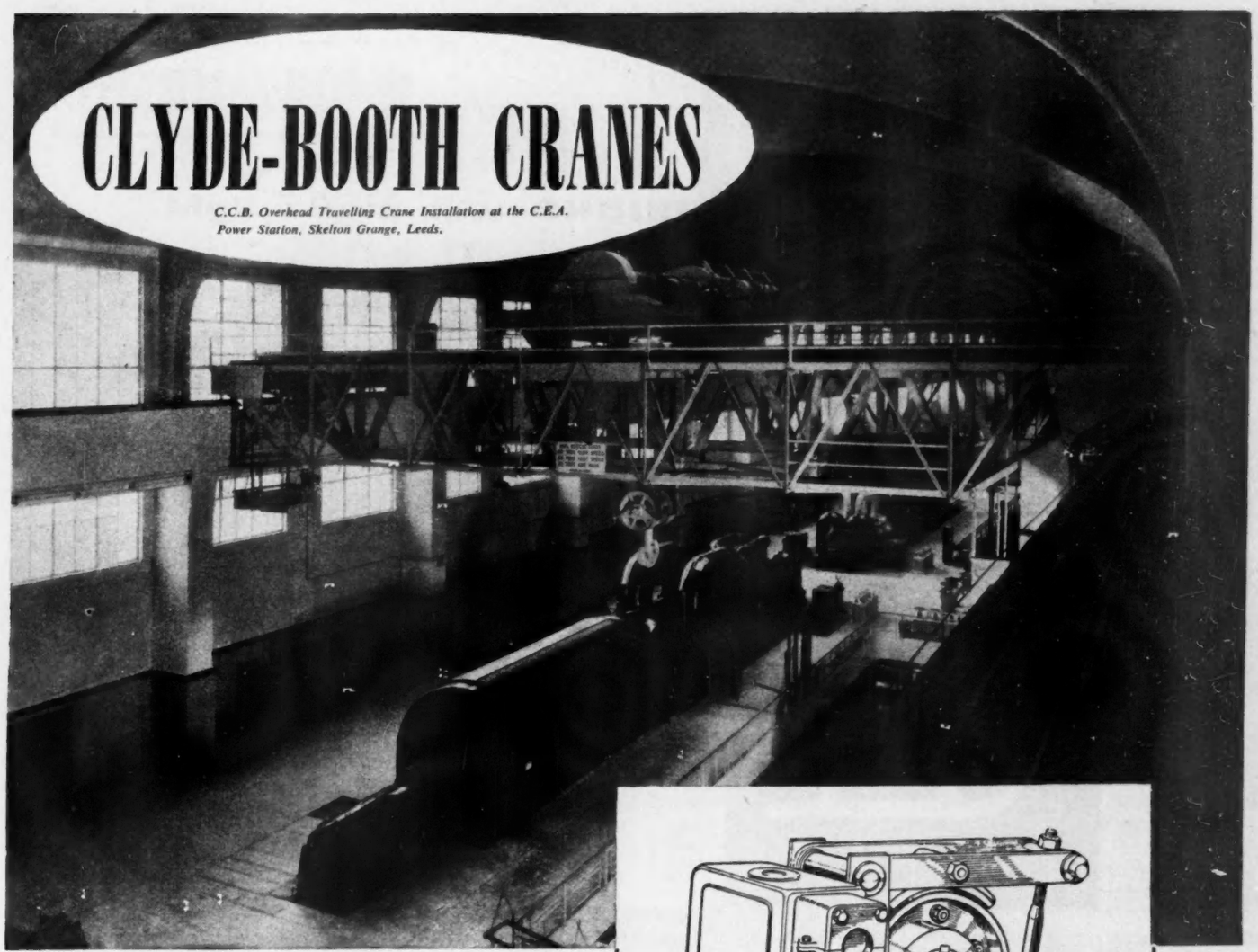

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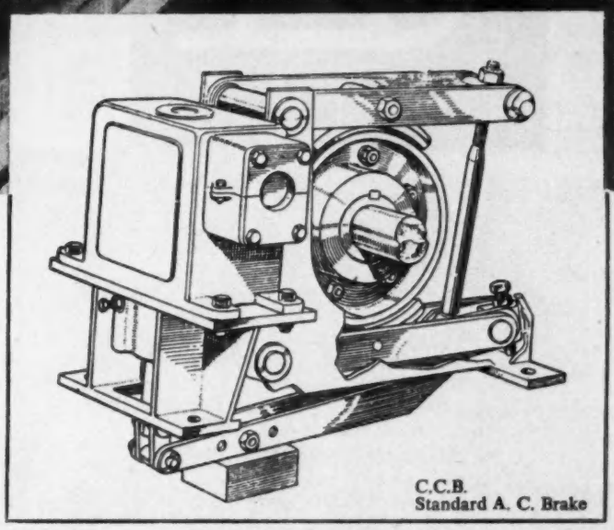

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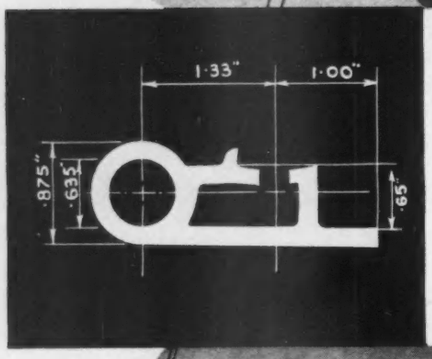

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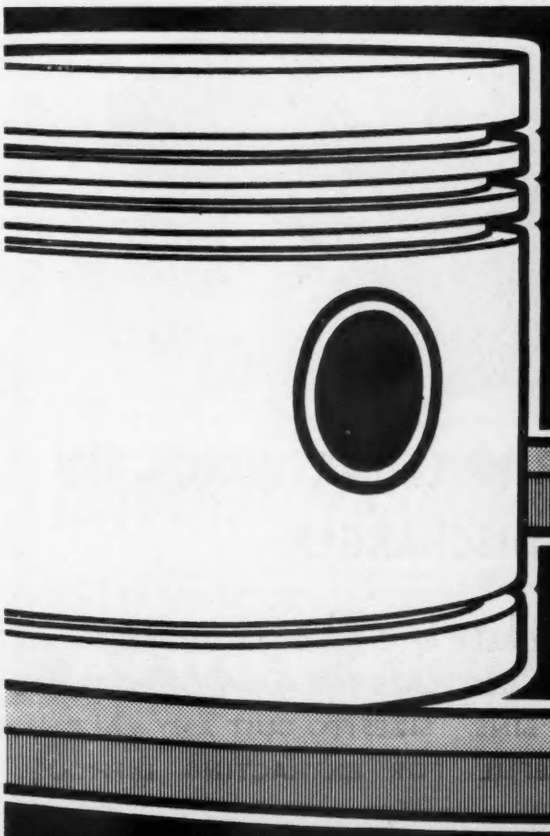

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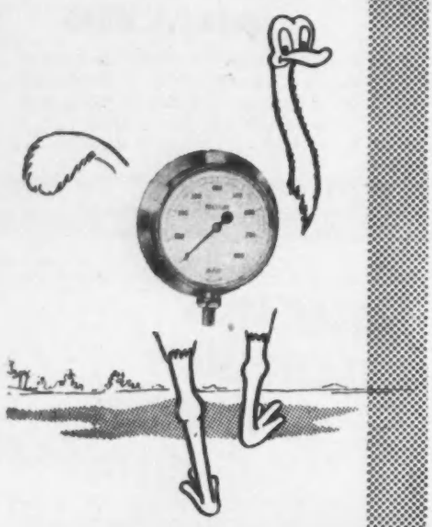

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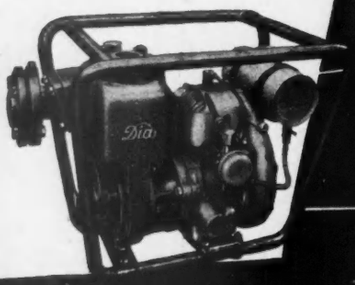

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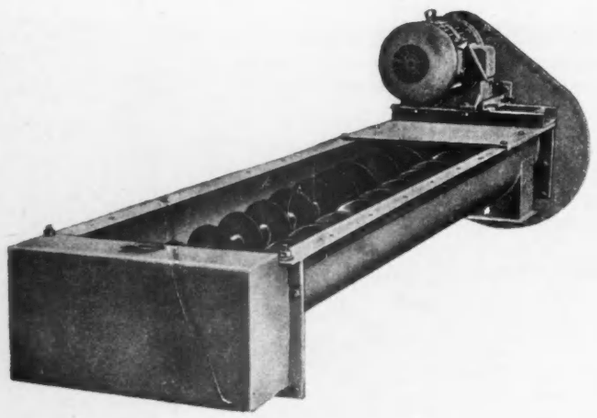

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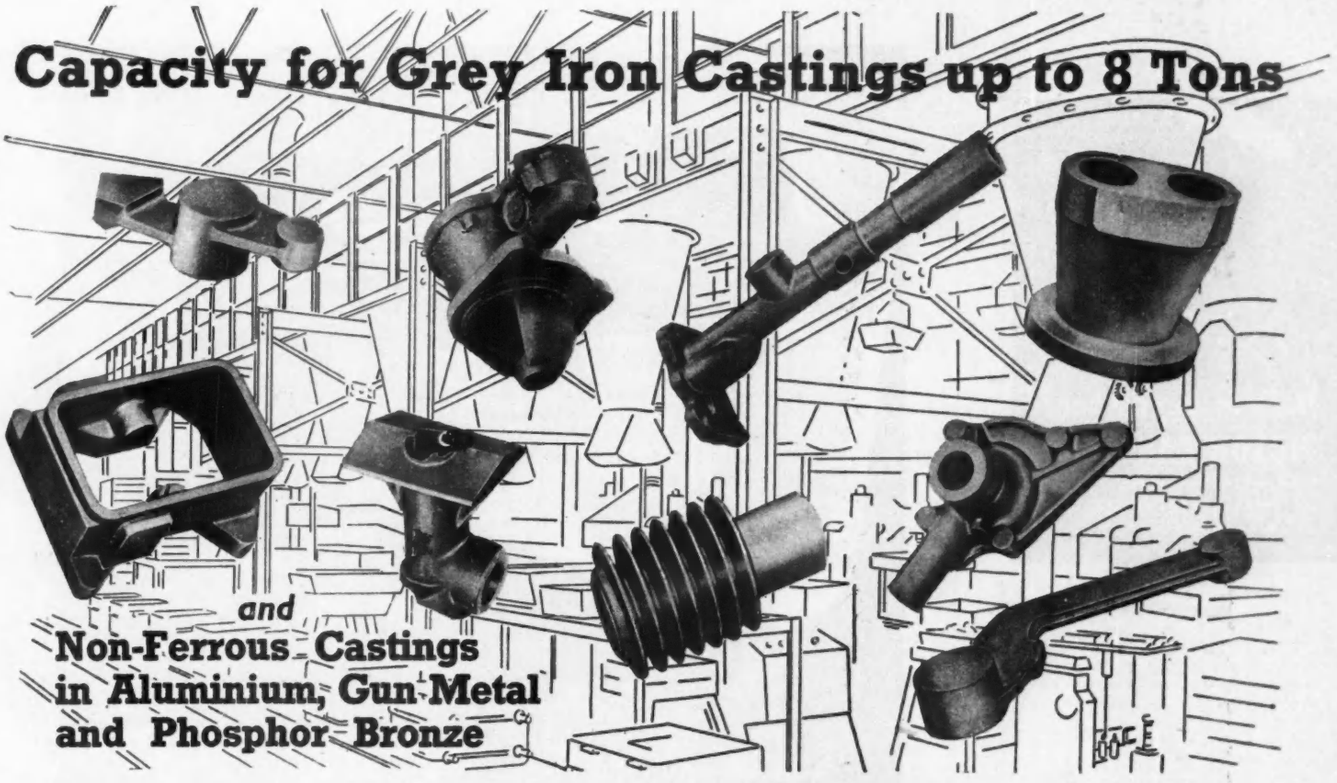

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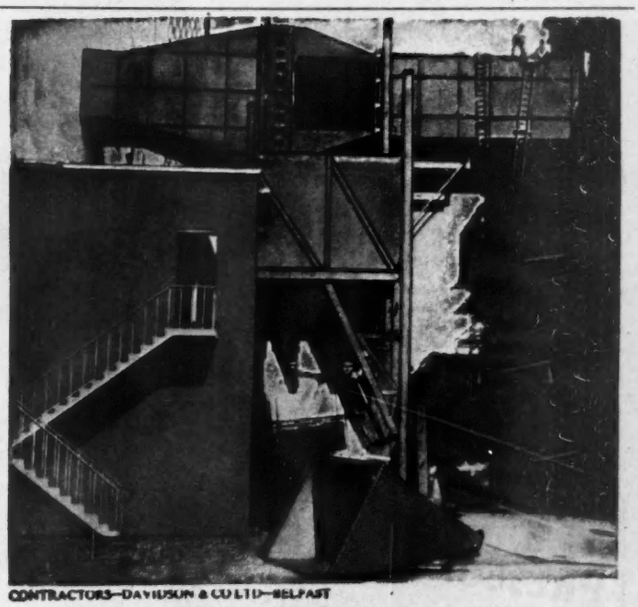

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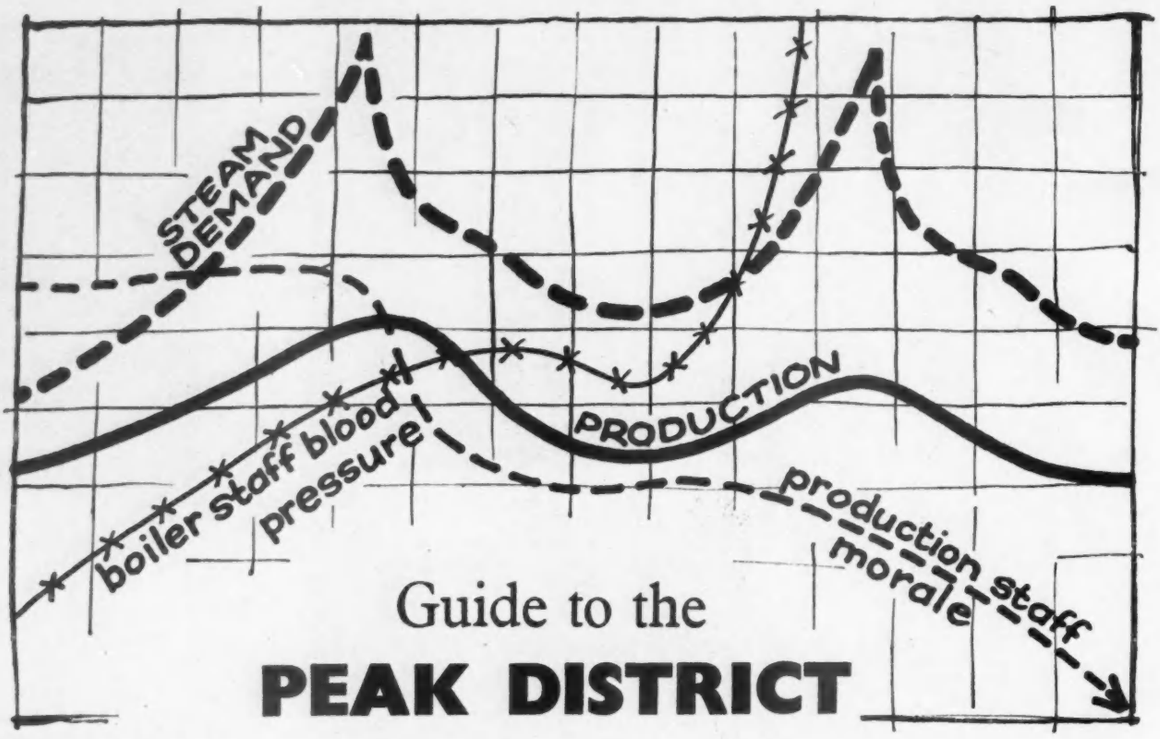

Guide to the **PEAK DISTRICT**

This isn't a very good picture of what happens during peak demand in steam-using plants. It doesn't need to be, for the outlines of the peak are all too familiar.

As departmental withdrawals of steam pile up, boiler pressure begins to fall away. Valves are opened wider to compensate, and demand increases. The boiler chaps force things at their end to try and keep pace, and then the real trouble starts.

When the boilers are being forced, priming water gets carried over into the steam mains, and steam quality drops. As a result, process units are trying to do their rated task with steam which is both insufficient and of low quality.

The production graph takes a hammering and so do the production people. And by the time they have adjusted themselves to the latest situation, cyclic demand has fallen again and the necessary readjustment has to go all the way back to the boiler house.

The best way of making our little sketch out of date is to look again at all your practices and techniques. The chances are that some of them survive from a bygone age, having never been questioned. A bit of questioning may throw new light on whether all your process operations need start at the same time, or whether your process departments and the boiler house really know each other's minds.

There may be more scope for steam storage than you realise. There are almost certainly more ways of using your "waste" heat—through a heat exchanger, for example, to preheat material being processed.

And any fresh look at your plant provides a wonderful opportunity to check the true heating efficiency of each of your units.

We believe that our bulletin "Steam for Process" can help eliminate your peak load problems, for it reviews practically and concisely all the factors which can make proper steam usage satisfying to the engineer as well as commercially profitable.

* * *

"Steam for Process" is, among other things, a handy way of reviewing this series of advertisements. May we post you a copy?

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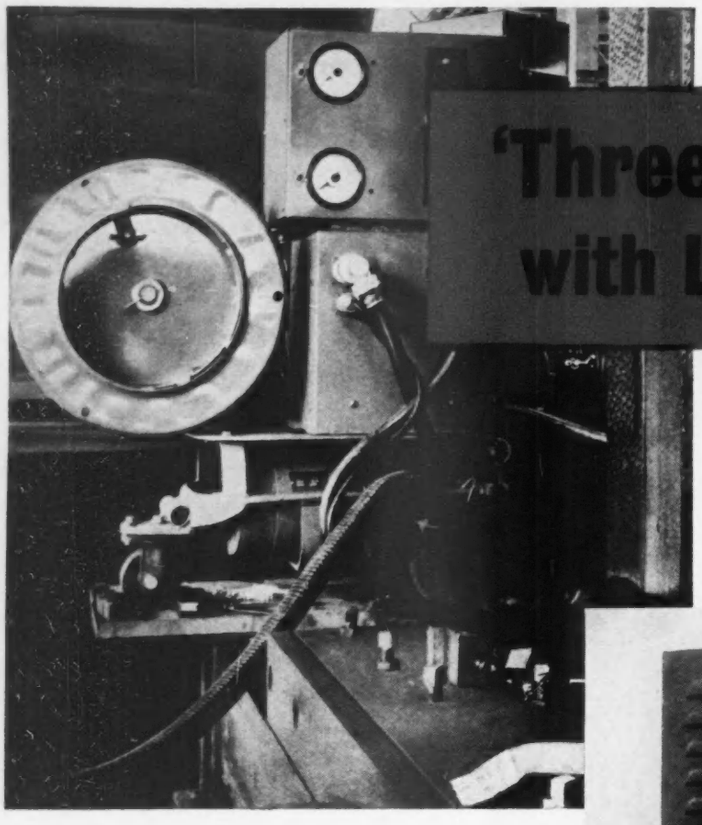
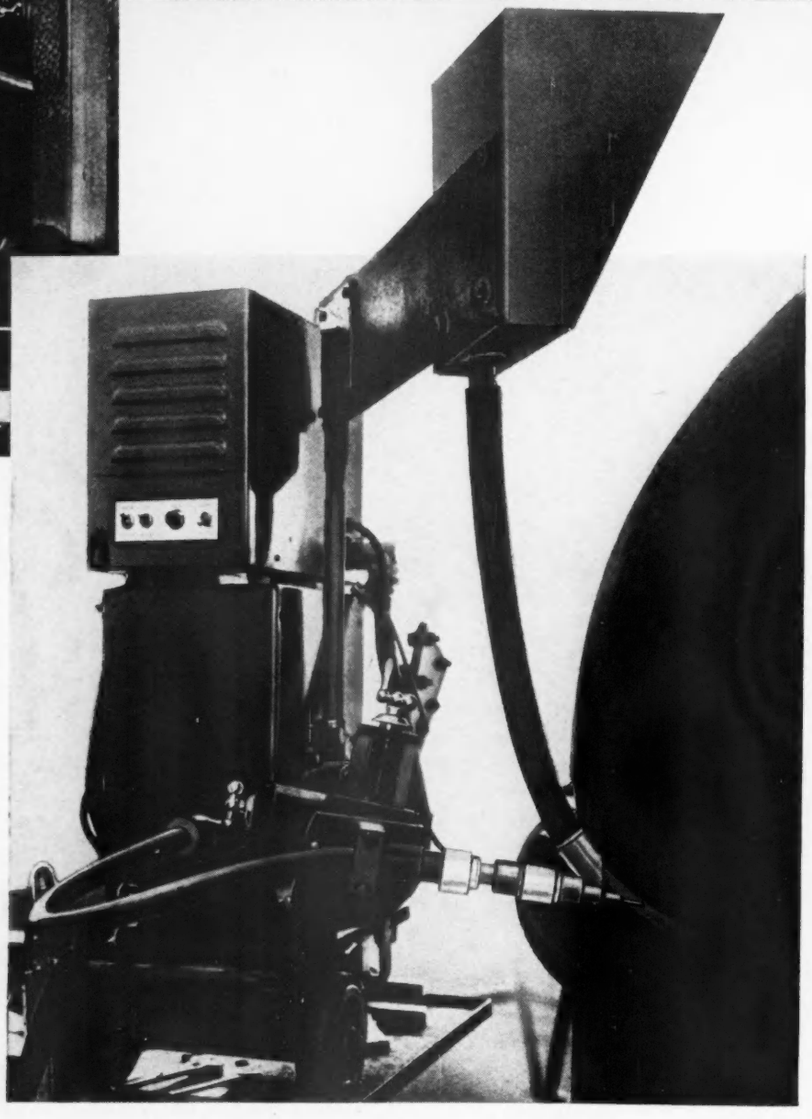


'Three o'clock' welding with LINCOLNWELD



THE LINCOLNWELD Universal Tractor in action at the Derby works of International Combustion Co. Ltd. The illustrations show the Universal Tractor automatically welding in the '3 o'clock' position, a section of one of 4 heat exchangers for The Advanced Gas Cooled Reactor, being built at Windscale, Cumberland, for the United Kingdom Atomic Energy Authority. (Photographs by the courtesy of International Combustion Co. Ltd. and U.K.A.E.A.)

UTI

Butt welding, Fillet welding, Lap welding and now horizontal/vertical '3 o'clock' welding—all are possible with the latest LINCOLNWELD UNIVERSAL TRACTOR Submerged Arc Welding Unit.

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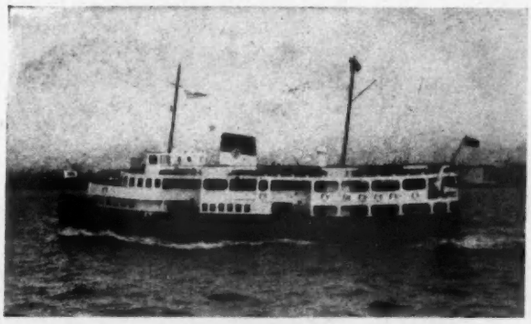

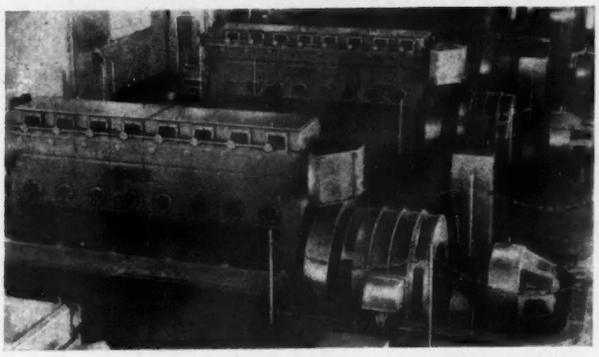

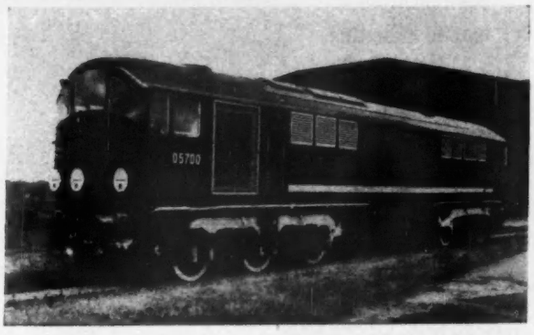

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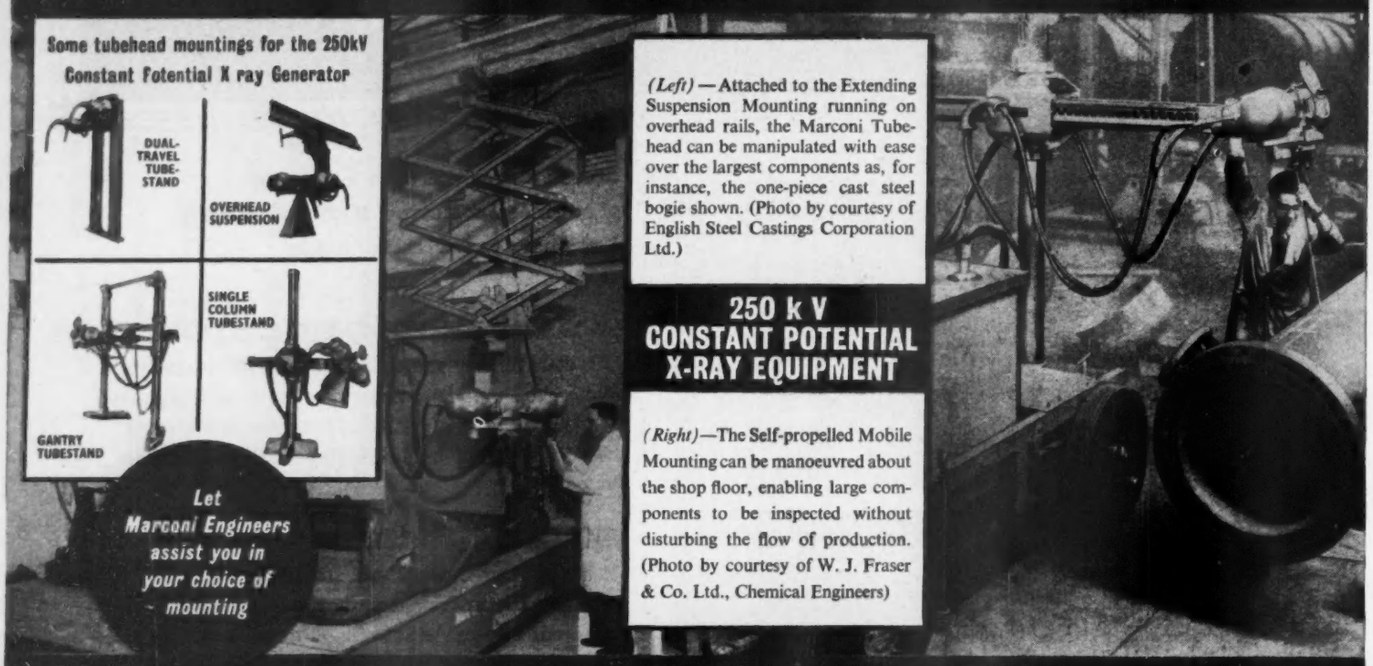
Let Marconi Engineers assist you in your choice of mounting



(Left) — Attached to the Extending Suspension Mounting running on overhead rails, the Marconi Tubehead can be manipulated with ease over the largest components as, for instance, the one-piece cast steel bogie shown. (Photo by courtesy of English Steel Castings Corporation Ltd.)

250 k V CONSTANT POTENTIAL X-RAY EQUIPMENT

(Right)—The Self-propelled Mobile Mounting can be manoeuvred about the shop floor, enabling large components to be inspected without disturbing the flow of production. (Photo by courtesy of W. J. Fraser & Co. Ltd., Chemical Engineers)

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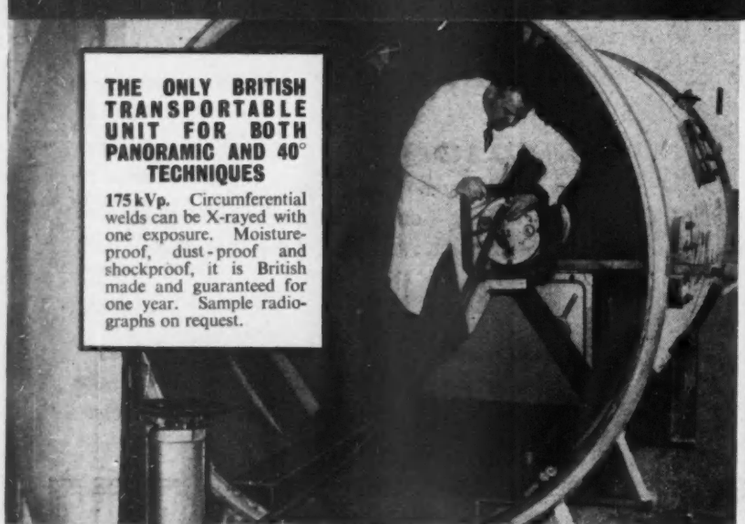

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IX 20

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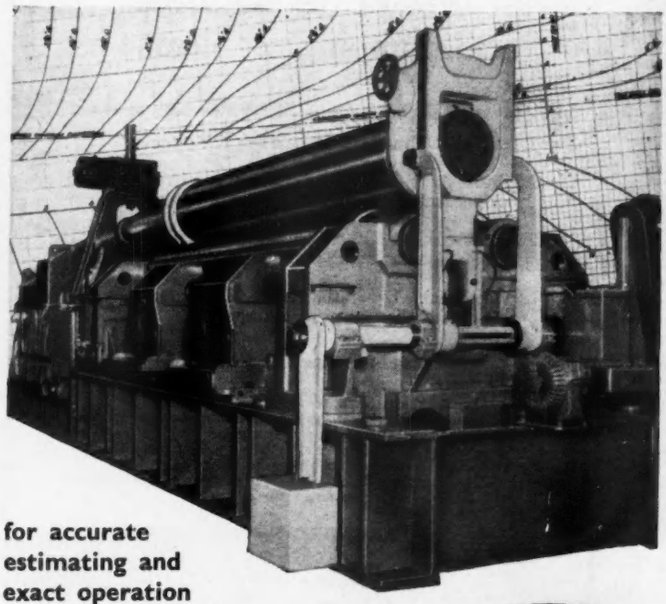

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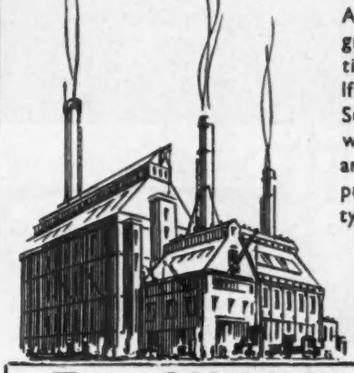

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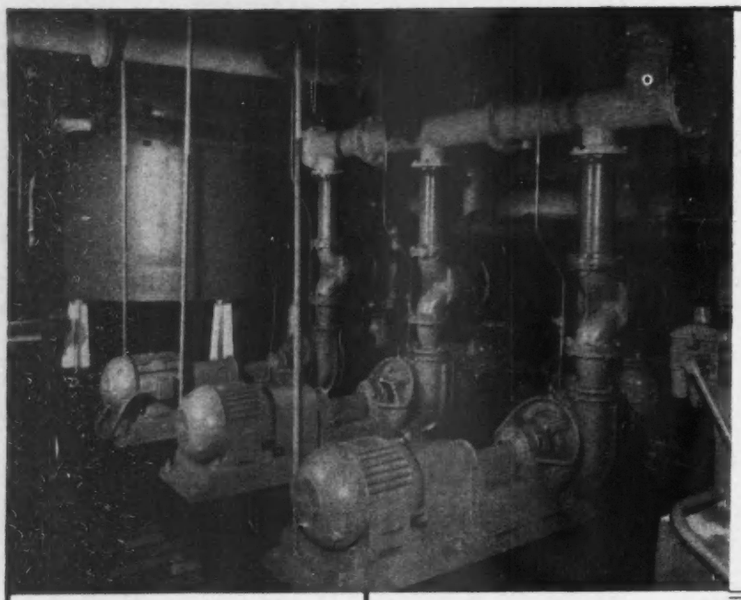

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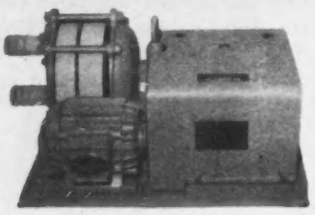

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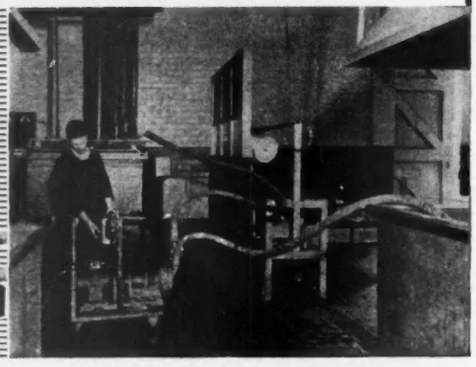

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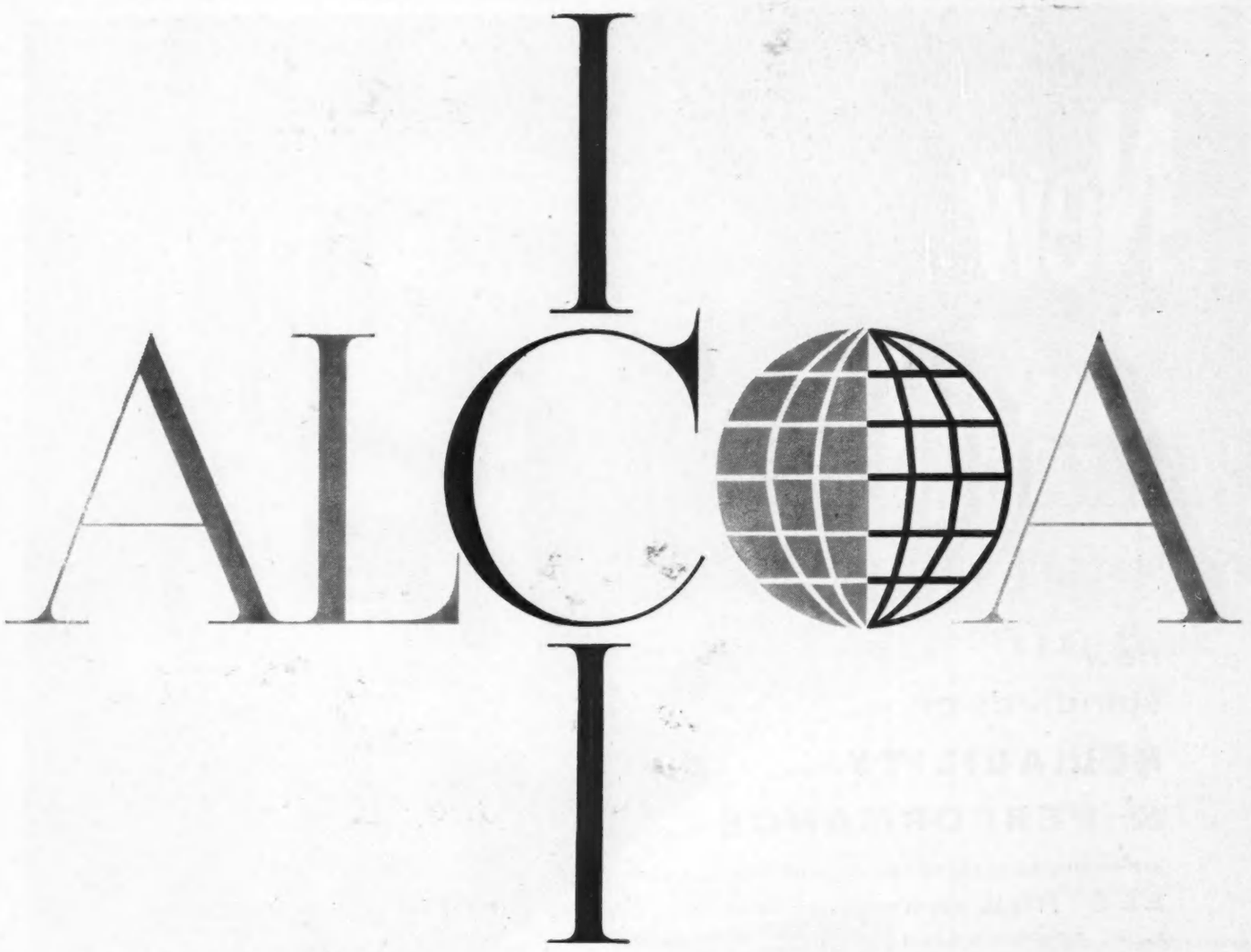

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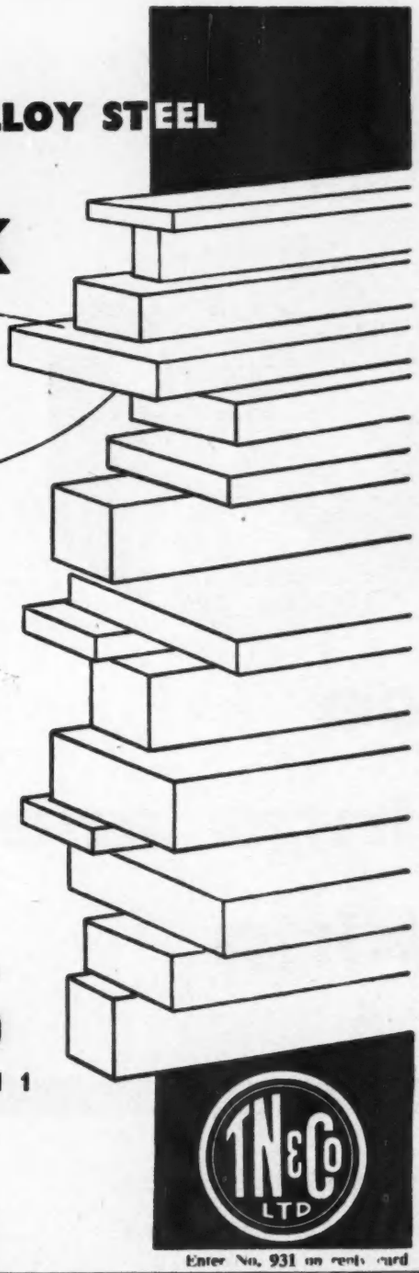

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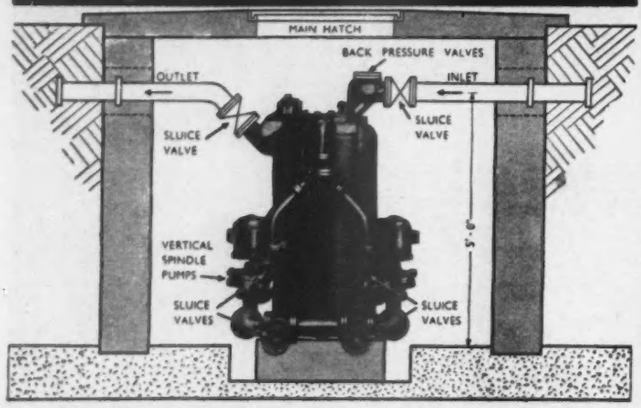

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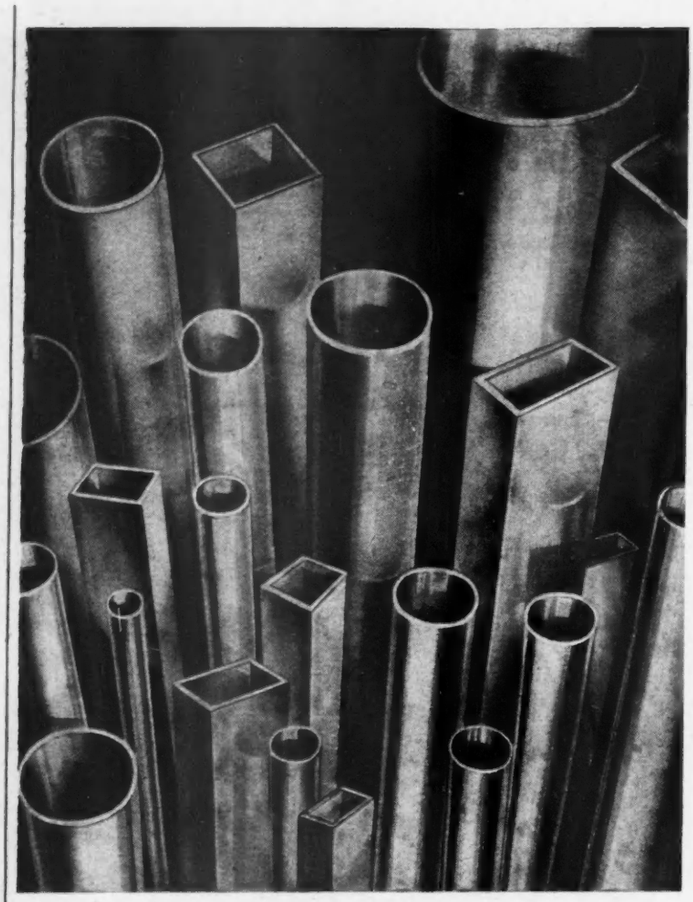

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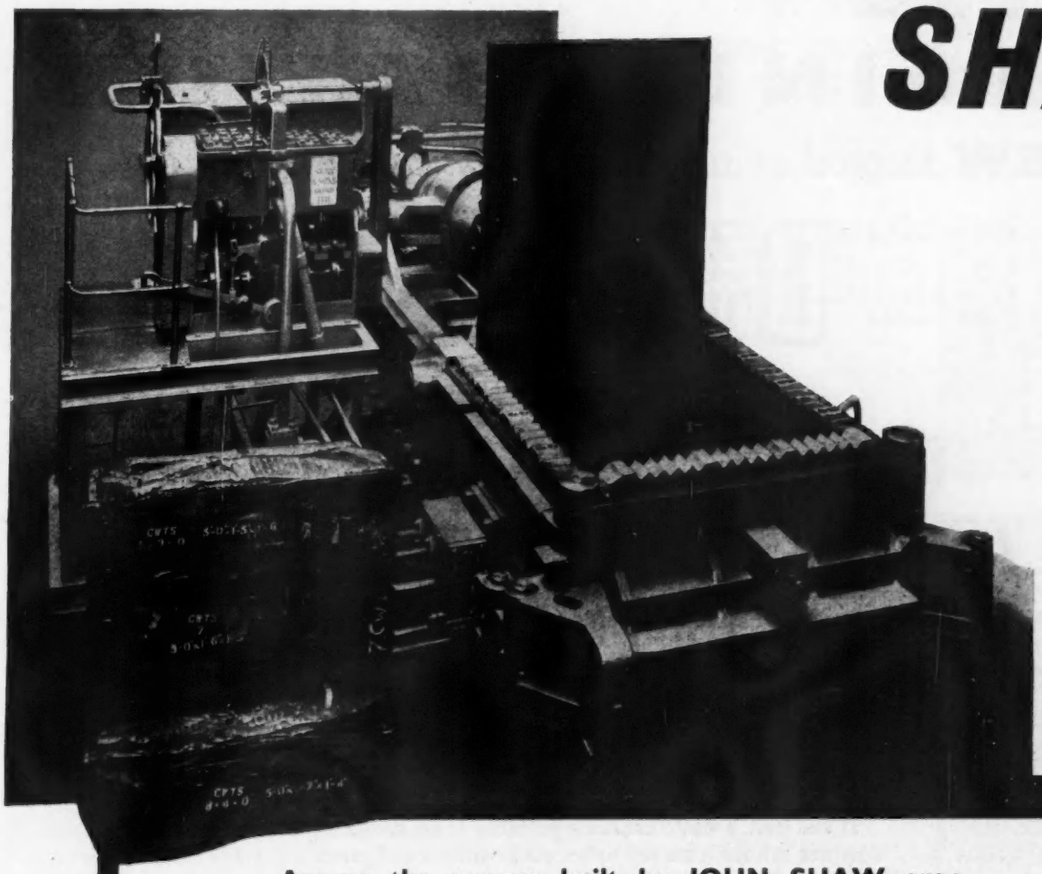

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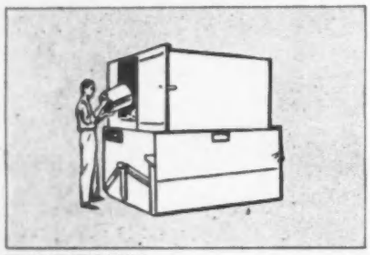

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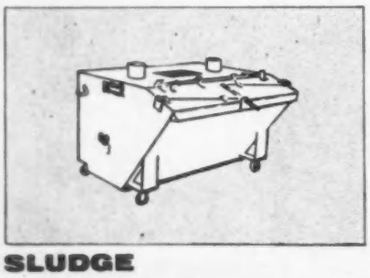

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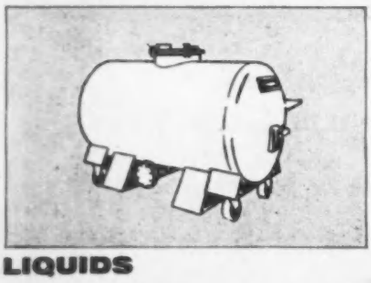

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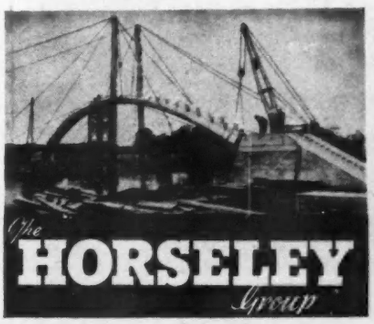

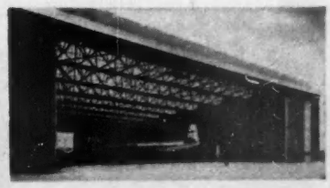

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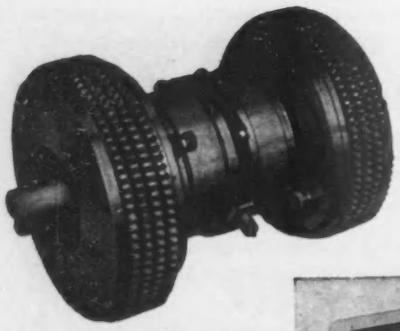

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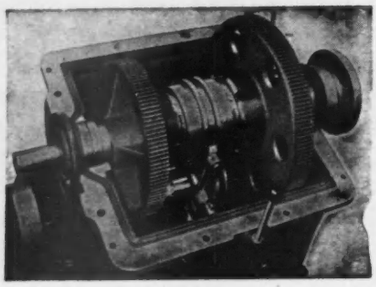

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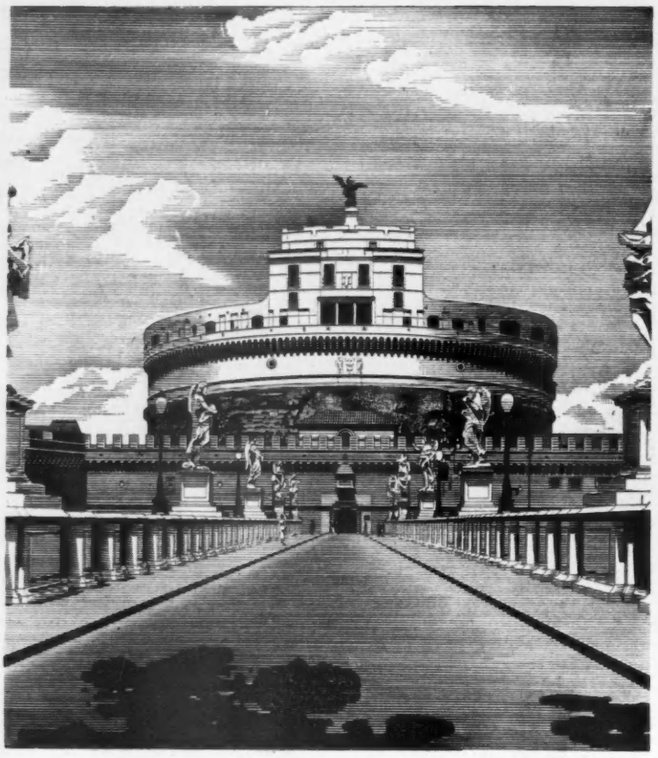

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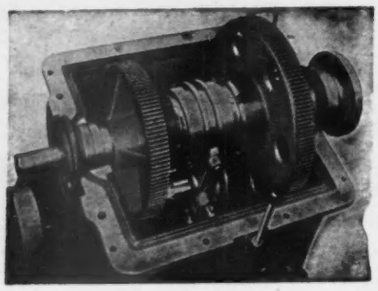

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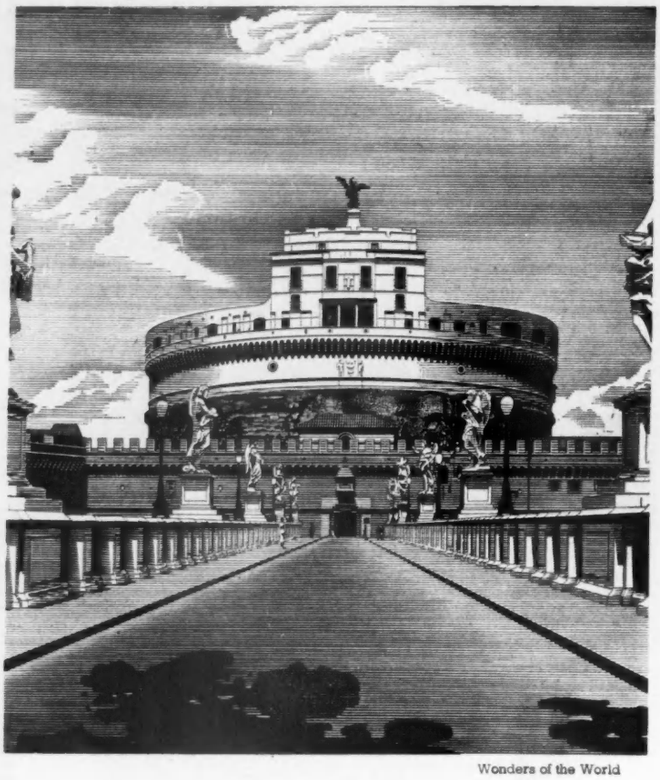

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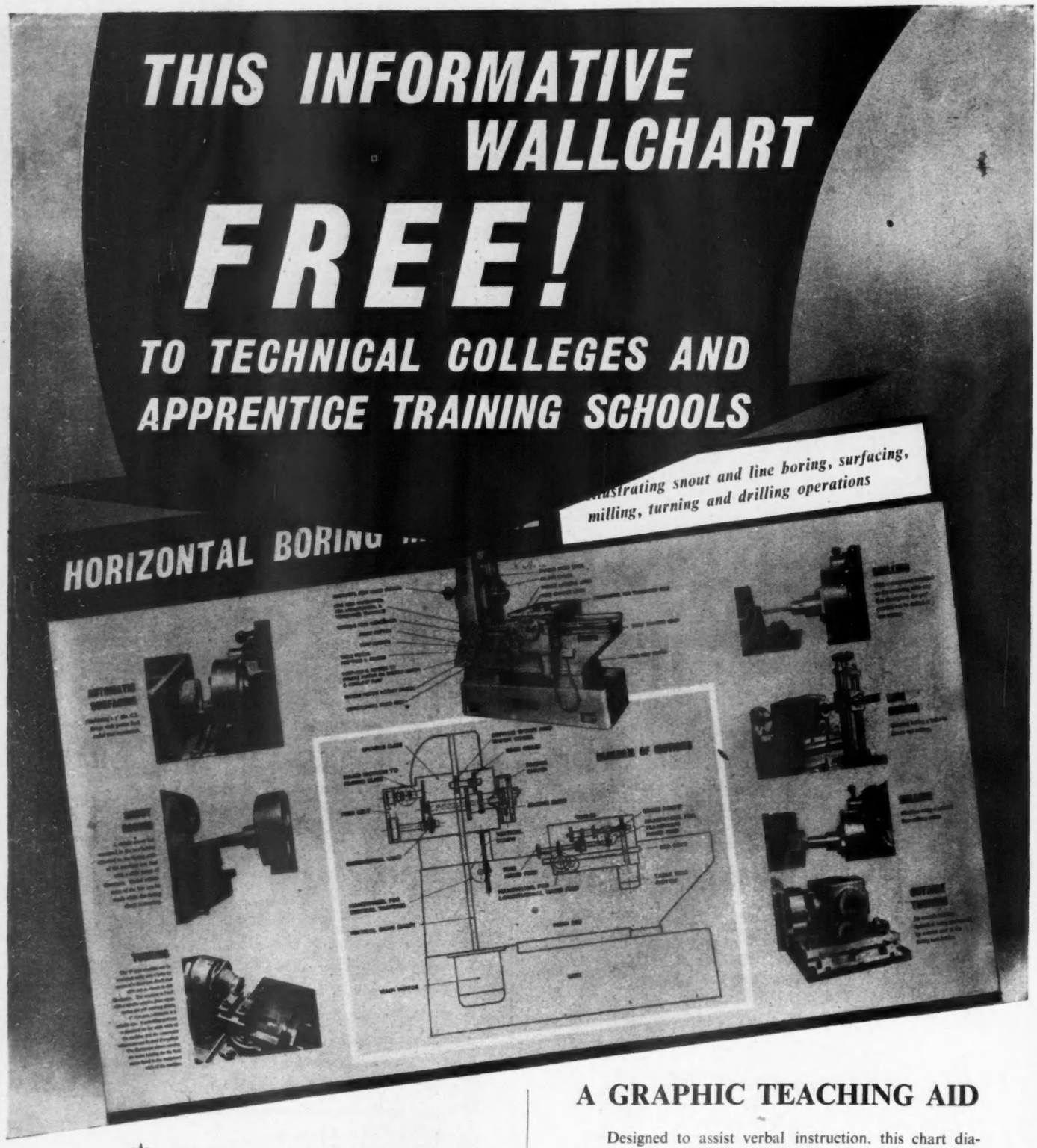

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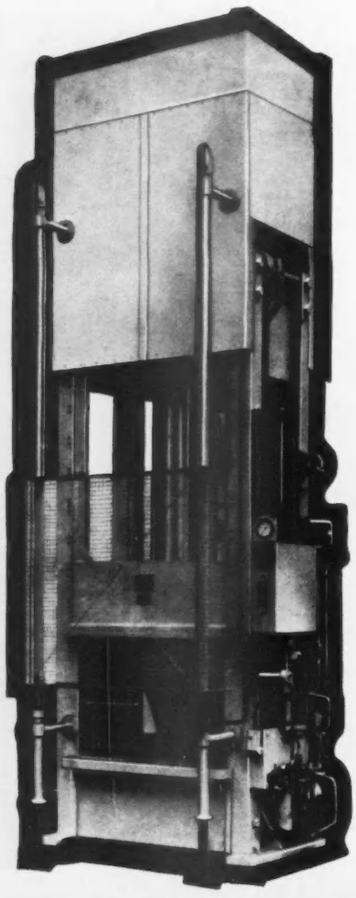

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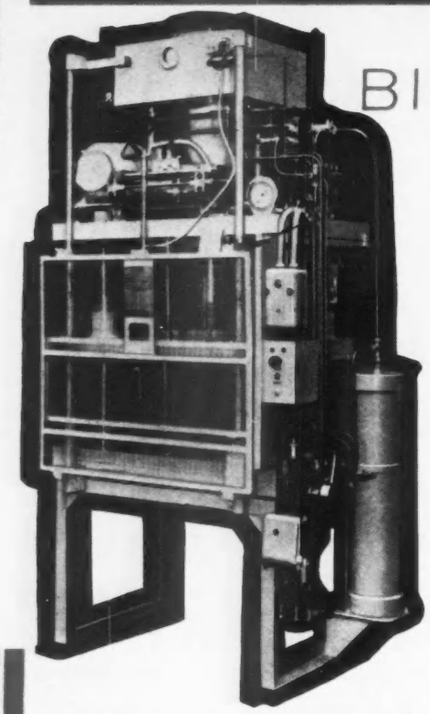

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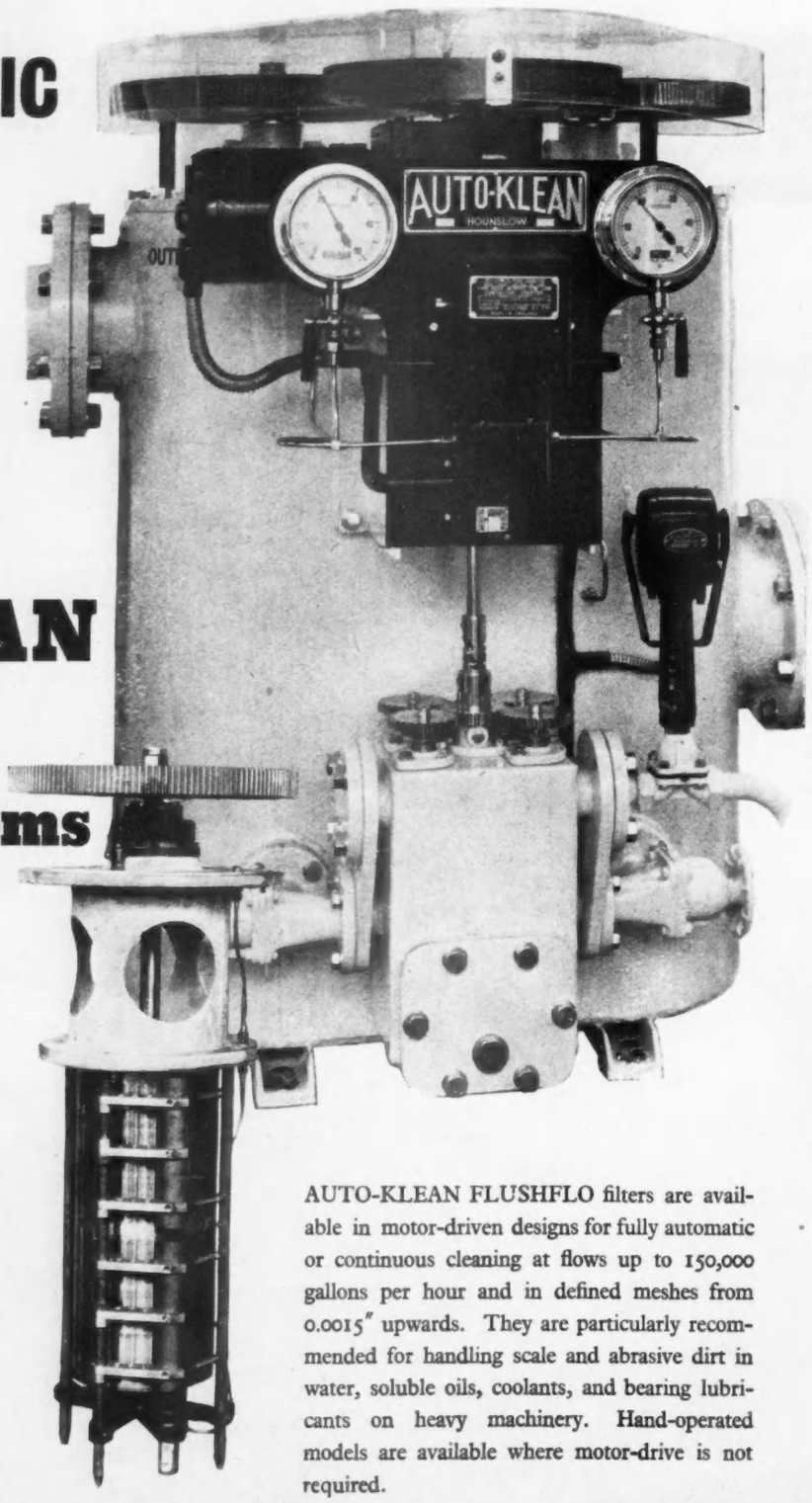

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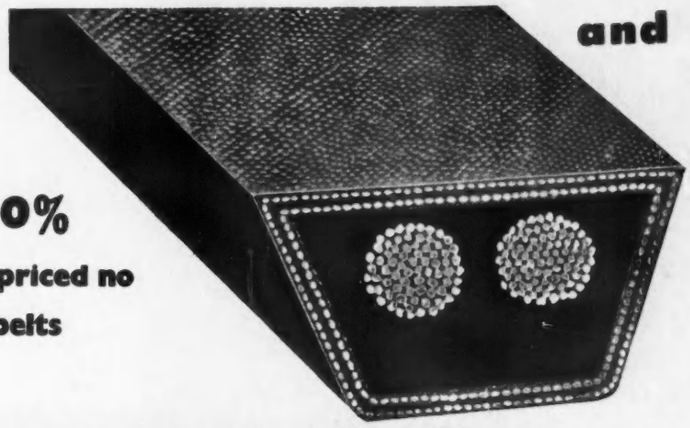

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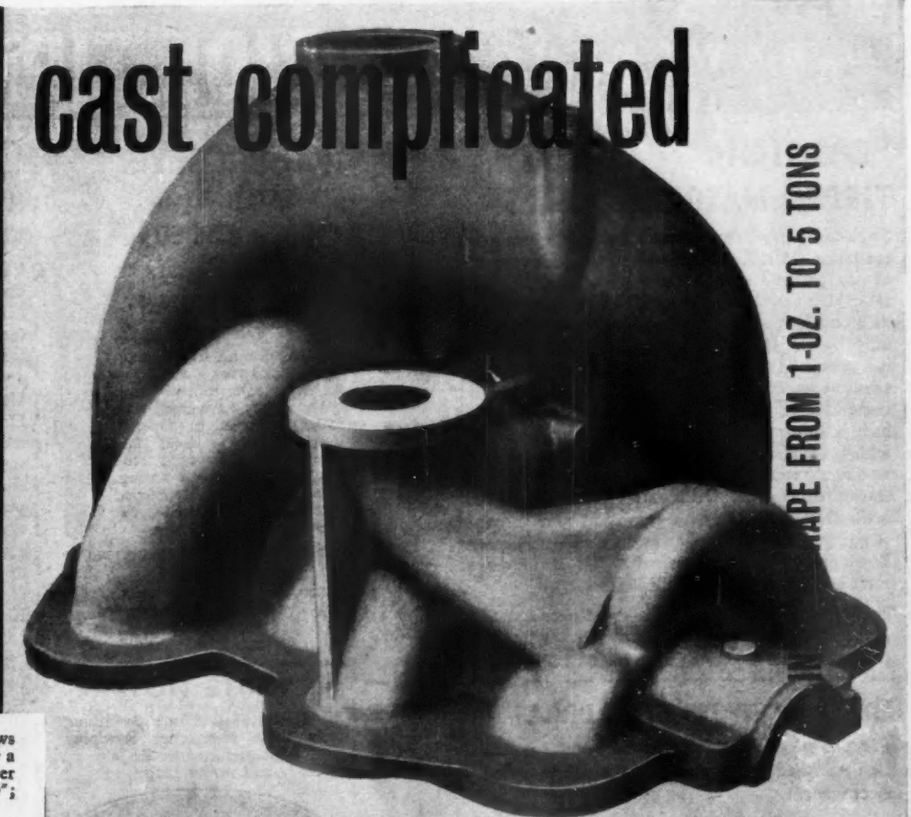

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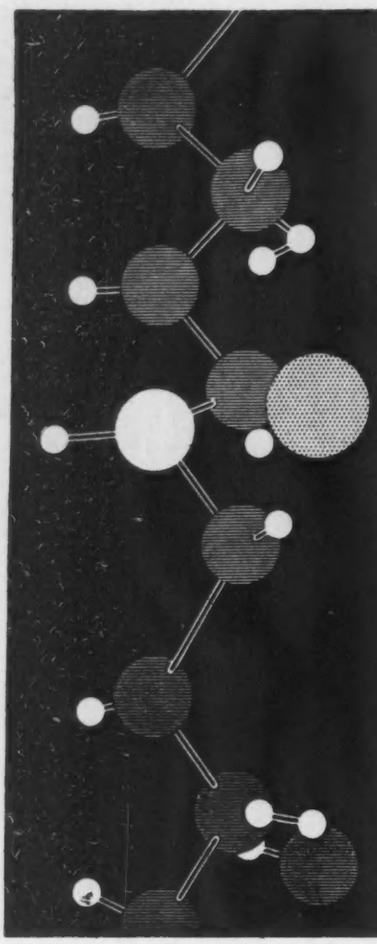

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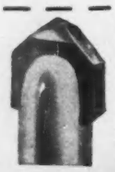

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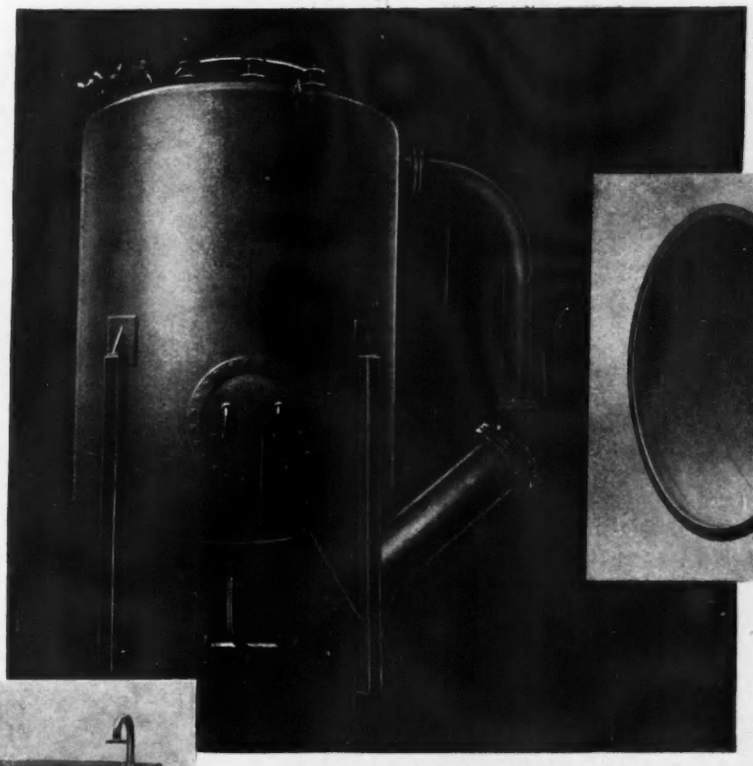

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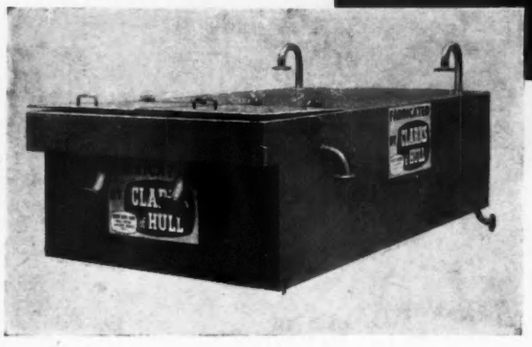

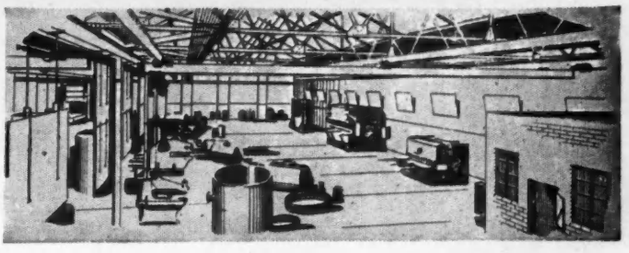

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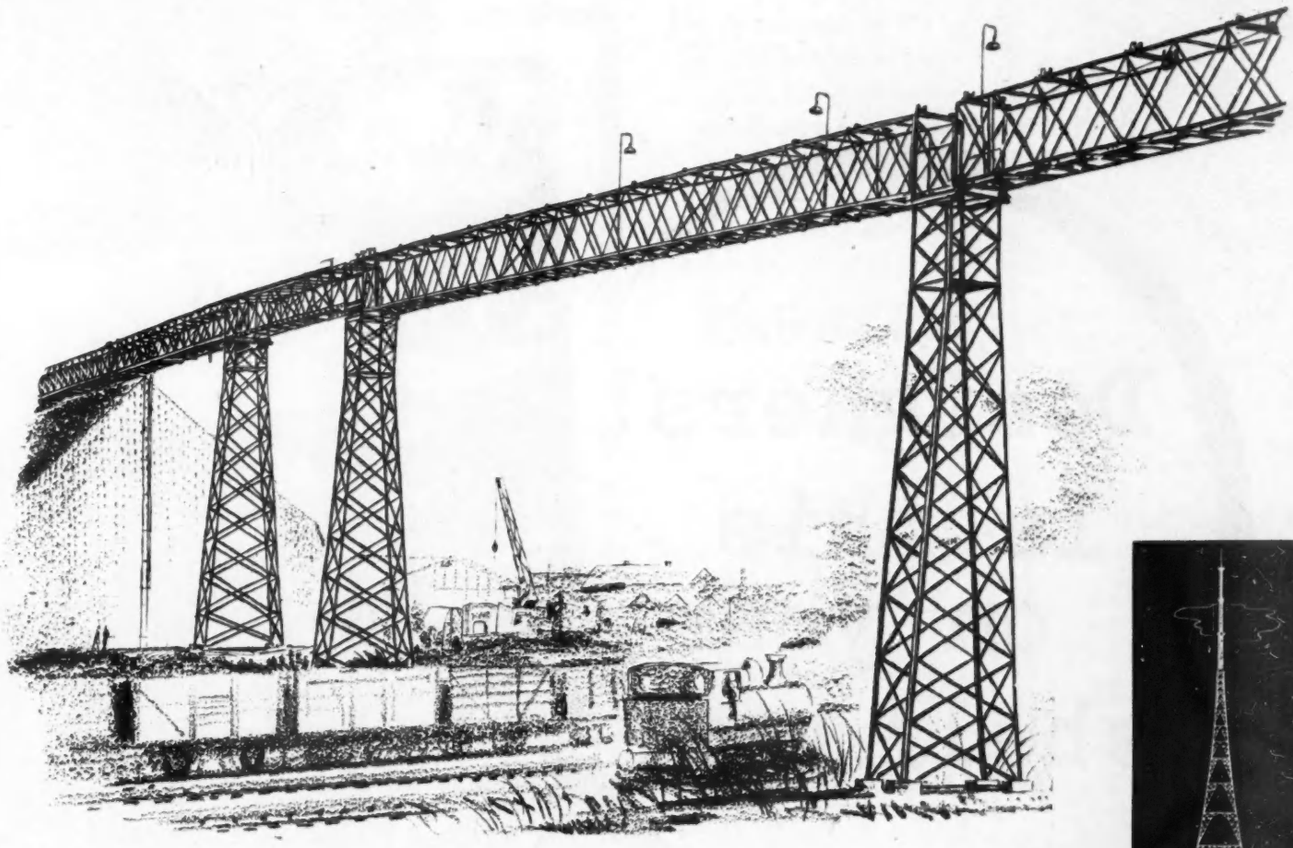

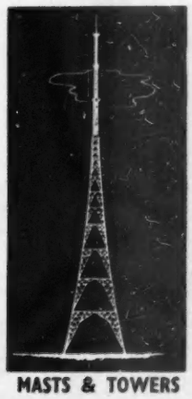

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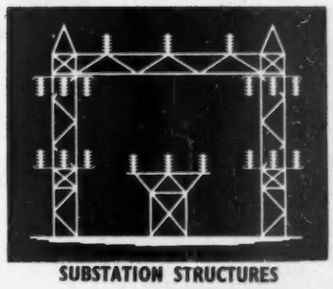

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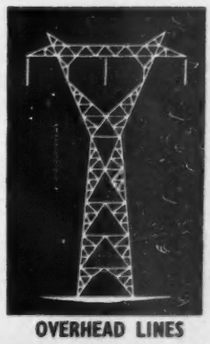

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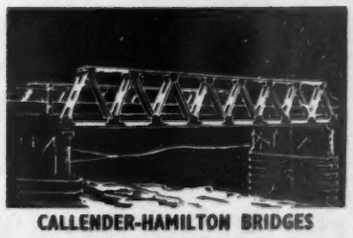

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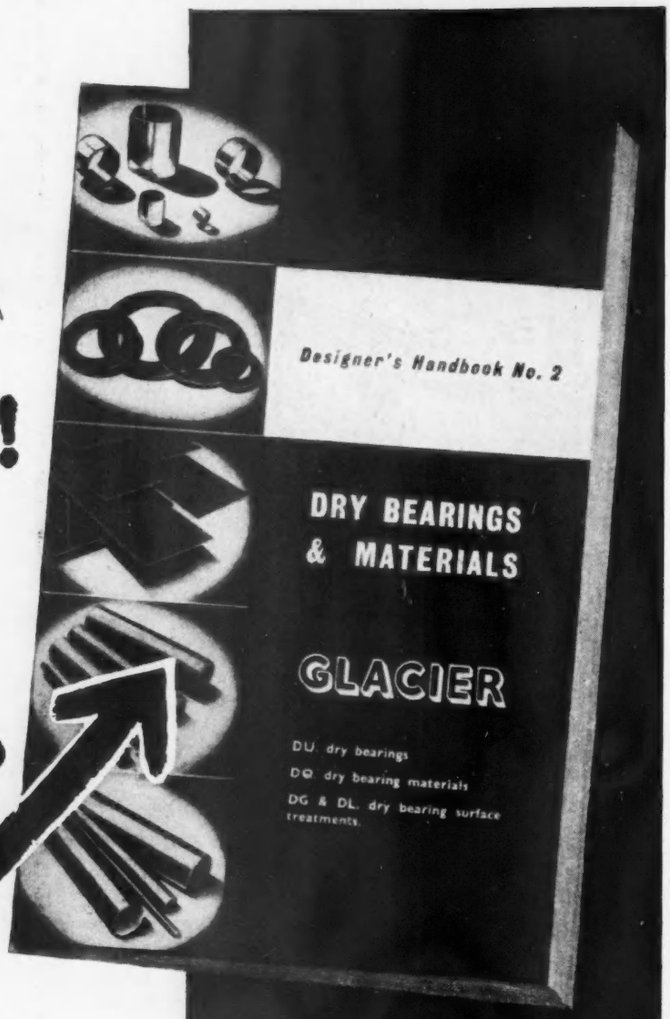

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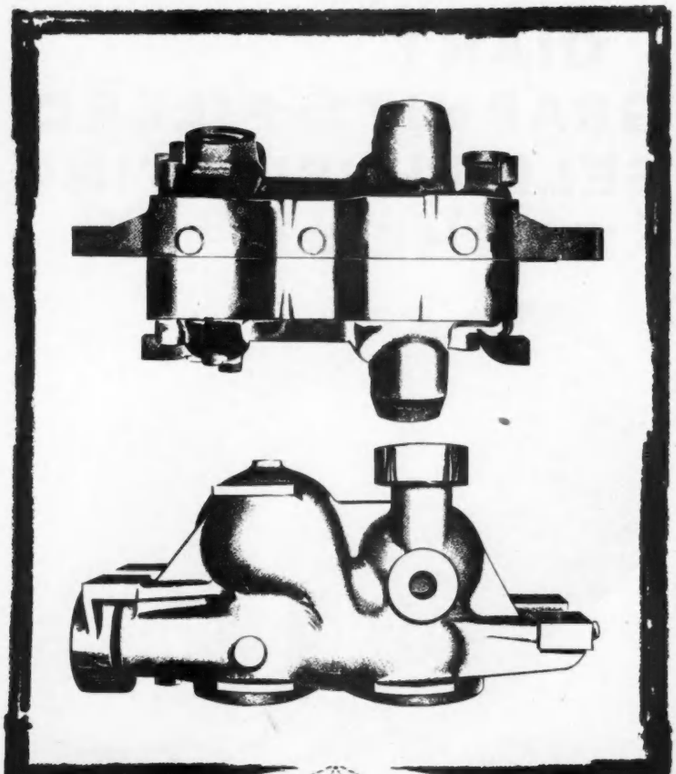

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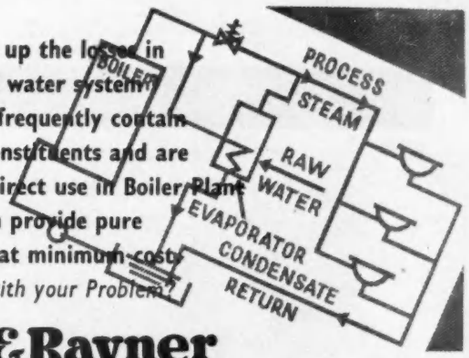

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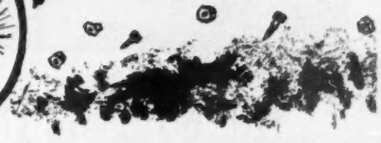

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V23

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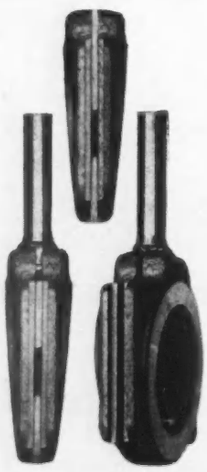

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Applied as a thin film to surfaces which encounter water or steam temperatures between 170°—1000°F., Apexior No. 1 is an effective, low cost protection for expensive boiler plant. It cuts corrosion to an absolute minimum; reduces scale formation. Any scale which forms can be easily and speedily removed without danger of damage to plant as it is non-adherent.

Other advantages come with Apexior No. 1: heat transmission is improved; and since Apexior is an inert coating, feed water is left completely free from discolouration or contamination. Keep step with industry to-day—be boiler wise and Apexiorise.

For full information on all aspects of Apexior No. 1 write for Booklet "Preventing Boiler Corrosion".

BPL/A48

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CLASSIFIED ADVERTISEMENTS

PUBLIC APPOINTMENTS · SITUATIONS VACANT · TENDERS · EDUCATIONAL · BUSINESSES and PREMISES · BUSINESS OPPORTUNITIES PATENTS · MISCELLANEOUS · AGENCIES · DIRECTORS · PARTNERSHIPS

Lineage Rate. 4/6 per line of approximately 6 words. Minimum 18/–. **Inch Rate.** 54/– per single column inch and pro rata. 12 lines to 1 inch.

There are reduced rates (i.e., not on a pro rata basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £29 10s. ½-page £54. Full page £100.

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Displayed and Illustrated Styles. The minimum size for a Displayed advertisement is 3 inches single column, for an Illustrated advertisement it is a ¼-page (12 column inches). Thereafter the sizes for both progress in steps 3 inches deep across 1, 2, 3 or 4 columns.

Use of Box Number. 2/– which includes forwarding of replies.

Copy Dates. Tuesday for publication on Friday of the same week. If proofs are wanted, copy is required on Thursday for publication on Friday of the following week.

Advertisements for publication should be addressed to :—**Classified Advertisement Dept., "THE ENGINEER," 28 Essex Street, Strand, London, W.C.2**

Urgent advertisements may be telephoned to CENtral 6565.

PUBLIC APPOINTMENTS

MIDDLESEX COUNTY COUNCIL EDUCATION COMMITTEE

HENDON TECHNICAL COLLEGE, THE BURROUGHS, HENDON, N.W.4.

LECTURERS

Applications are invited for the following posts :

(a) PRINCIPAL LECTURER in Mechanical Engineering to teach Applied Thermodynamics to post-Higher National Diploma level.

Candidates must possess high academic qualifications and be Corporate Members of the Institution of Mechanical Engineers. Appropriate teaching and industrial experience essential.

(b) TWO SENIOR LECTURERS in Electrical Engineering to teach :

(1) Electrical Measurements.

(2) Electronics to post-Higher National Diploma level.

Candidates must possess a good honours degree, be Corporate Members of the Institution of Electrical Engineers, and have appropriate teaching and industrial experience.

Salary within the range (men) :

(a) £1788–£1951 per annum.

(b) £1588–£1801 per annum.

Application forms and further details (s.a.e.) from the Clerk to the Governing Body, Town Hall, Hendon, N.W.4. Closing date 26th February, 1960.

C. E. GURR, M.Sc., Ph.D.,
E8885 Secretary to the Education Committee.

MANCHESTER COLLEGE OF SCIENCE AND TECHNOLOGY

(FACULTY OF TECHNOLOGY IN THE UNIVERSITY OF MANCHESTER)

MECHANICAL RESEARCH ENGINEER

The College is engaged on a large-scale research programme into the automatic control of machine tools with the support of D.S.I.R. A Senior Research Engineer is required to be responsible for the mechanical engineering aspects of the work, including the design, development and application of measuring and control devices. Special experience in the field of servo-mechanisms is essential.

Salary, according to qualifications, in the range of £1200 to £1500 per annum. Superannuation scheme.

Further particulars and form of application may be obtained from the Registrar, The Manchester College of Science and Technology, Manchester, 1, to whom completed forms should be returned by Saturday, 27th February, 1960 E8814

ROYAL AIRCRAFT ESTABLISHMENT, TECHNICAL COLLEGE, FARNBOROUGH, HANTS.

SENIOR LECTURER IN SERVO-MECHANISMS

Applications invited for post of SENIOR LECTURER IN SERVO-MECHANISMS, to teach subject for Dip. Tech. and A.F.R.Ae.S.

University Degree or equivalent and preferably some industrial and/or teaching experience required. Facilities for research available. Duties to commence as soon as possible.

Burnham Scale for Technical Colleges : £1550 by £50 to £1750.

Details and application forms from Principal of College for return within fourteen days. E8863

LOUGHBOROUGH COLLEGE OF TECHNOLOGY

SENIOR LECTURER

Applications are invited for the post of SENIOR LECTURER IN THERMODYNAMICS, in the Department of Mechanical Engineering. Applicants should have had industrial or research experience and, preferably, possess a University Degree. Encouragement will be given to undertake research and consulting work.

Salary scale : £1550 by £50 to £1750 per annum, the commencing salary being determined by previous experience and qualifications. The post is pensionable.

Application forms and further information may be obtained from the Registrar. (In reply, please quote 4/C.) E8842

PUBLIC APPOINTMENTS

CITY OF BIRMINGHAM EDUCATION COMMITTEE

VACANCIES FOR TEACHING STAFF IN TECHNICAL COLLEGES

Applications are invited for the following posts to commence duty on 1st September, 1960. Separate application forms for each post and further particulars may be obtained from the Principal of the College concerned (stamped, addressed envelope) and should be returned to him as early as possible. Burnham (Further Education) Salary Scales as follows :

LECTURER : Men : £1370 by £35 to £1550 ; Women : £1100 by £28 to £1240 plus equal pay increments.

ASSISTANT GRADE "B" : Men : £700 by £27 10s. to £1150 ; Women : £630 by £22 to £920, plus equal pay increments.

ASSISTANT GRADE "A" : Men : £520 by £27 10s. to £1000 ; Women : £468 by £22 to £800, plus equal pay increments.

Additional increments above the minimum of the above scales may be granted for time spent in teaching, industry, commerce, professional work or research. There are also additions to the scales for Grade "B" and Grade "A" assistants for a degree or for equivalent professional qualifications.

ASTON TECHNICAL COLLEGE
Whitehead Road, Aston, Birmingham, 6.
Principal : D. D. Stockley, B.Sc., M.I.Mech.E.

LECTURER in Mechanical Engineering subjects up to Higher National Certificate standard. Degree or equivalent desirable ; previous teaching and industrial experience essential.

HANDSWORTH TECHNICAL COLLEGE
Golds Hill Road, Birmingham, 21.
Principal : H. Marshall, B.Sc.Tech., A.M.I.Mech.E., A.M.I.Prod.E.

ASSISTANT GRADE "A" to teach elementary classes in C.G.I. Machine Shop Engineering Courses and particularly Workshop Practice and Processes.

MATTHEW BOULTON TECHNICAL COLLEGE
Suffolk Street, Birmingham, 1.
Principal : J. C. Martin, M.A., A.M.I.E.E., A.M.Brit.I.R.E.

ASSISTANT, GRADE "B" for City and Guilds Fabrication of Steel Courses.

E. L. RUSSELL,
E8881 Chief Education Officer.

NORTH THAMES GAS BOARD

ASSISTANT ENGINEERS (MECHANICAL)

ASSISTANT ENGINEERS (MECHANICAL) required at various of the Board's works for supervising maintenance of Mechanical, Steam and Power plant.

Higher National Certificate is the minimum qualification required.

Starting salaries will be within the range £900 to £1200 per annum according to qualifications and experience.

The successful candidates will be required to join the contributory staff pension scheme.

Applications, giving full details, should be sent to the Staff Controller, North Thames Gas Board, 30, Kensington Church Street, W.8, quoting reference TE/773. E8822

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

NATIONAL ENGINEERING LABORATORY, EAST KILBRIDE, GLASGOW

PRINCIPAL SCIENTIFIC OFFICER

Pensionable post at National Engineering Laboratory, East Kilbride, Glasgow, for Engineer for research on the application of servo-control to machine tools.

Qualifications : normally First or Second Class Honours Degree in Engineering or high professional attainment. Experience of electrical servo-design and development and a good knowledge of servo-theory is essential. Knowledge of hydraulic servo-technique or machine tool design an advantage.

Salary scale : (men) £1420–£2020. Starting pay may be above minimum. Good housing prospects.

Write, Civil Service Commission, 17, North Audley Street, London, W.1, for application form, quoting S/5099/60/11. Closing date, 10th March, 1960. E8864

PUBLIC APPOINTMENTS

GOVERNMENT OF WESTERN NIGERIA

VACANCY FOR TECHNICAL INSTRUCTOR (MOTOR VEHICLE MECHANIC)

Applications are invited from suitable candidates for the post of TECHNICAL INSTRUCTOR (MOTOR VEHICLE MECHANIC).

Qualifications : Candidates must possess full technological or Final Certificate of the City and Guilds of London Institute in Motor Vehicle Mechanical work, and must have served a full apprenticeship in the trade. Subsequent industrial experience with teaching or apprentice training will be an advantage.

Duties : To give instructions to apprentices in Motor Vehicle (Petrol and Diesel) maintenance, and repair work, including use of Garage equipment and Machine tools at a Trade Training Centre. The work is predominantly practical in character, but ability to give instructions in allied theory—workshop calculations, Trade Science and Drawing is desirable. The successful candidate will be expected to take part in the student and extra-mural life of the Centre.

Terms of Appointment : On contract terms for a minimum of 3 tours of 10–12 months each in the first instance. Salary is within the range of £1398–£1734 per annum, according to experience, plus gratuity at the rate of £37 10s. for each completed three months' service. Free first passages for officer and his family on first appointment, and when proceeding on leave ; free medical treatment for officer and his family. Accommodation is provided at low rentals.

Applications should be completed in triplicate on the prescribed form obtainable from the Official Secretary (Recruitment Branch), Office of the Commissioner for Western Nigeria, 178-202, Great Portland Street, London, W.1, from whom further particulars may also be obtained.

Closing date : 18th February, 1960.

E8884

CITY OF LEEDS

WATERWORKS DEPARTMENT

APPOINTMENT OF STAFF

Applications are invited for the following appointments :

(a) ENGINEERING ASSISTANT (New Works, J.N.C. Scale "B." Salary within the range of £1320–£1485.

(b) ENGINEERING ASSISTANT—A.P.T. V. £1220–£1375.

(c) ENGINEERING ASSISTANT—A.P.T. IV. £1065–£1220.

(d) SENIOR DRAUGHTSMAN—A.P.T. II. £765–£880.

(e) DRAUGHTSMAN—A.P.T. I. £610–£765.

Applicants for post (a) must be Corporate Members of the Institution of Civil Engineers and should have experience in the design and construction of Impounding Reservoir Schemes.

Applicants for posts (b) and (c) must be Corporate Members of the Institution of Civil Engineers Experience with a Water Undertaking and/or in the design and construction of Impounding Reservoir Schemes will be an advantage. For post (b) experience in the design and installation of pumping plants is desirable.

Applicants for post (d) must be neat draughtsmen and have experience in Civil Engineering Drawings. Experience with a Water Undertaking will be an advantage.

Superannuation payable. Medical examination.

Applications, on forms obtainable from the undersigned, should be delivered not later than 12 noon on Tuesday, 1st March, 1960, endorsed with the description of the post applied for.

Canvassing disqualifies.

KENNETH L. FORSTER,
General Manager and Engineer.
Waterworks Department,
Civic Hall,
Leeds, 1.
4th February, 1960. E8860

PUBLIC APPOINTMENTS

SOUTH WEST METROPOLITAN REGIONAL HOSPITAL BOARD

REGIONAL ENGINEER'S DEPARTMENT

SENIOR ASSISTANT ENGINEERS (HEATING AND VENTILATING)

Applications are invited for the following appointments on the permanent staff of the Board generally in accordance with the Whitley Council conditions of service.

SENIOR ASSISTANT ENGINEERS (HEATING AND VENTILATING) : The commencing salary will be at the minimum of the scale £1050 by £30 (3) by £35 (3) to £1245 p.a., plus London Weighting allowance of £50 p.a. (scale under review). Applicants should be Corporate Members of the Institution of Mechanical Engineers and should be experienced in the preparation of specifications, drawings and estimates for large engineering installations in hospitals and large public buildings.

Applications, stating age, qualifications, experience, present appointment and salary, together with the names and addresses of three referees, should be sent to the undersigned at 40, Eastbourne Terrace, London, W.2, by not later than 27th February, 1960.

E. G. BRAITHWAITE,
E8882 Secretary.

CITY OF BRADFORD WATER DEPARTMENT

APPOINTMENT OF ENGINEERING STAFF

Applications are invited for three superannuable appointments :

(a) TWO SENIOR ENGINEERING ASSISTANTS, Grade A.P.T. V (£1220–£1375), and

(b) ONE MECHANICAL ENGINEERING ASSISTANT, Grade A.P.T. IV (£1065–£1220).

Candidates for appointments (a) must be Corporate Members of the Institution of Civil Engineers, and for appointment (b) must be Corporate Members of the Institutions of Mechanical, Civil or Electrical Engineers.

Candidates for appointments (a) should have a wide experience in water supply. They will be required for work in connection with the maintenance of the water undertaking, and particularly in the design and construction of large aqueduct pipelines, rapid gravity filtration plant, reservoir works, boosters, etc. Appointment (b) covers work on the maintenance and general upkeep of transport, mechanical and electrical plant.

Applications, stating age, training, professional qualifications and experience, together with the names of two referees, must reach the undersigned by the 5th March, 1960.

HENRY PATTEN,
Town Hall, Town Clerk.
Bradford, 1. E8874

FYLDE WATER BOARD

SENIOR ASSISTANT ENGINEER (STRUCTURAL)

SENIOR ASSISTANT ENGINEER (STRUCTURAL). Salary Scale A.P.T. V (£1220–£1375). Commencing salary £1220 per annum.

Applicants must be Associate Members of either the Institution of Structural Engineers or the Institution of Civil Engineers, and must have had extensive experience of reinforced and prestressed concrete design and construction. Some knowledge of modern methods of design of steel structures will be an advantage.

The Board has an extensive capital works programme in hand amounting to over £2,500,000 in the next five years. Successful applicants will, therefore, have ample opportunities for an interesting career. The Board supply an area of approximately 425 square miles and a population of 450,000.

Further details of work in hand may be obtained from the undersigned, also application forms which should be returned before 2nd March, 1960.

The appointment will be subject to the provisions of the Local Government Superannuation Acts and Regulations thereunder, and successful applicants will be required to pass a medical examination.

FRANK LAW, B.Sc. Tech., M.I.C.E.
Engineer to the Board.
Sefton Street,
Blackpool. E8817

Classified Advts. continued on page 120

PUBLIC APPOINTMENTS

SOUTH WEST METROPOLITAN REGIONAL HOSPITAL BOARD

REGIONAL ENGINEER'S DEPARTMENT

SENIOR ASSISTANT ENGINEERS (HEATING AND VENTILATING)

Applications are invited for the following appointments on the permanent staff of the Board, generally in accordance with the Whitley Council conditions of service.

SENIOR ASSISTANT ENGINEERS (HEATING AND VENTILATING)

The commencing salary will be at the minimum of the scale, £1050 by £30 (3) by £35 (3) to £1245 per annum, plus London Weighting allowance of £50 per annum (scale under review). Applicants should be Corporate Members of the Institution of Mechanical Engineers and should be experienced in the preparation of specifications, drawings and estimates for large engineering installations in hospitals and large public buildings.

Applications, stating age, qualifications, experience, present appointment and salary, together with the names and addresses of three referees, should be sent to the undersigned at 40, Eastbourne Terrace, London, W.2, by not later than 27th February, 1960.

E. G. BRAITHWAITE,
Secretary.

E8866

CITY OF SHEFFIELD

ASSISTANT STRUCTURAL ENGINEER

Appointment of ASSISTANT STRUCTURAL ENGINEER, Grade A.P.T. IV. Salary: £1065–£1220.

Applications are invited from qualified Civil or Structural Engineers for the above appointment on the staff of the City Architect, Mr. J. L. Womersley.

Candidates should possess a thorough knowledge of the design and construction of all types of building structures and foundation work, and the person appointed will be required to assist the Engineer, at present a Chartered Civil Engineer, responsible for all such work carried out by the Department, including schools, flats, public and industrial type buildings.

The post is eminently suitable for University Graduates seeking design experience for Professional Interview.

The commencing salary will be at a point within the above scale commensurate with the successful candidate's experience and qualifications.

Applications, stating age, qualifications, experience, present and past appointments (with dates and salaries), and the names and addresses of two persons to whom reference may be made should reach me by Monday, 22nd February, 1960.

JOHN HEYS,
Town Clerk.

Town Hall,
Sheffield, 1.

E8849

CENTRAL ELECTRICITY GENERATING BOARD

EASTERN DIVISION

MAINTENANCE ENGINEER (MECHANICAL)

Applications are invited for the following appointment:

MAINTENANCE ENGINEER (MECHANICAL) Rye House Generating Station (Hoddesdon, Herts.).

Salary N.J.B., Class "G," Grade 6, £1025 by £20 to £1085 per annum.

Applicants should have served an apprenticeship and have had experience with the maintenance of modern pulverised fuel-fired boilers, turbines and coal and ash handling plants. Operating and supervisory experience and technical qualifications to at least Ordinary National Certificate (Mechanical) standard will be of advantage.

Applications quoting reference S.V. No. 1264, stating age, qualifications, experience and present position, should be sent to the Controller, Central Electricity Generating Board, Eastern Division, West Farm Place, Chalk Lane, Cockfosters, Barnet, Herts, to arrive not later than 20th February, 1960.

W. N. C. CLINCH,
Controller.

E8832

MANCHESTER REGIONAL HOSPITAL BOARD

ARCHITECTURAL ENGINEERING AND SURVEYING STAFF

A substantial expansion of the hospital capital building programme offers valuable opportunities to ambitious Architects, Engineers, and Surveyors. Vacancies are available in the following grades. The salary scales quoted are at present under review.

(a) Principal Assistant, Grade Scale II—£1195–£1420 year; ARCHITECTS
(b) Senior Assistant Grade—£1050–£1245 a year; ARCHITECTS, QUANTITY SURVEYORS, ENGINEERS (Mechanical, Heating and Ventilating), ENGINEERS (Electrical).
(c) Assistant Grade—£730–£1055 a year; ARCHITECTS, SURVEYORS (Land and Quantity), ENGINEERS (Mechanical, Heating and Ventilating), ENGINEERS (Electrical).
(d) Sub-professional Grade—£545–£765 a year; ARCHITECTS, SURVEYORS (Land and Quantity).
(e) DRAUGHTSMEN—£445–£660 a year.

Candidates for posts listed under (a), (b) and (c) must possess full professional qualifications, and for posts under (d), intermediate qualifications. Draughtsmen must have had at least 3 years' previous experience. All posts are subject to National Health Service conditions and are superannuable. Application forms, to be returned by 29th February, 1960, are obtainable from the Secretary of the Board, Cheetwood Road, Manchester, 8. E8730

PUBLIC APPOINTMENTS

FEDERAL GOVERNMENT OF NIGERIA

ELECTRICAL INSPECTOR

Under the Chief Inspector, to inspect electrical supply undertakings and large consumers installations, including factories, mines and oil wells, and to investigate and conduct enquiries into electrical accidents.

Contract appointment for one or two tours. Salary range: £1374–£1788. Gratuity of £37 10s. for each three months' satisfactory service. Quarters at moderate rent. Free passages. Allowance for children maintained in United Kingdom. Generous home leave.

Candidates must be A.M.I.E.E. or be exempt the Institution's examination and have been apprenticed to an electrical supply undertaking or large industrial undertaking with at least 7 years' experience of responsibility involving the planning, erection and maintenance of electrical transmission and distribution systems or works electrical plants. A thorough knowledge of electrical supply and wiring regulations as they apply in the United Kingdom is essential.

Write, Director of Recruitment, Colonial Office, London, S.W.1, stating full names, age, qualifications and experience, quoting BCD 99/14/014/D4.

E8798

GOVERNMENT OF JAMAICA

PUBLIC WORKS DEPARTMENT

EXECUTIVE ENGINEER (MECHANICAL)

Under the Director of Electrical and Mechanical Services, to control the maintenance and allocation of heavy earth-moving units, vehicles and general mechanical plants; to carry out a statistical analysis of the operating cost of all equipment; to co-ordinate with the Executive Engineer in charge of Workshops in the ordering of new equipment, &c.

Contract appointment for one tour of three years. Salary range: £1400–£1600 a year. Gratuity 20 per cent. of salary. House provided at reasonable rent. Free passages.

Candidates up to 50 years must be A.M.I.Mech.E., with relevant knowledge and experience.

Write to Director of Recruitment, Colonial Office, London, S.W.1, giving full names, age, qualifications and experience, quoting BCD 112/32/021/D4.

E8799

EAST AFRICAN RAILWAYS AND HARBOURS ADMINISTRATION

ASSISTANT ENGINEER (MECHANICAL)

To undertake supervision of Plant Repair Workshops and inspection of Civil Engineering machinery and plant.

Pensionable appointment. Salary range: £1170–£1755. Free passages. Free accommodation, rented furniture.

Candidates, 28–40 years, must be A.M.I.Mech.E., with thorough knowledge of the operation and maintenance, including major overhaul, of all mechanical plant used for civil engineering works, and have experience of routine workshops accounting, storekeeping and general staff administration.

Write, Director of Recruitment, Colonial Office, London, S.W.1 giving full names, age, qualifications and experience, quoting BCD 173/031/D4. E8867

BRITISH WATERWAYS

DRAUGHTSMAN

DRAUGHTSMAN required, must be experienced in Civil Engineering Work. Salary according to age rising to £731 per annum at age 36; Contributory Superannuation Scheme; certain railway privilege travel facilities; Luncheon Club.

Apply in writing giving full particulars as to age and experience, to: Divisional Staff Assistant, British Waterways, Church Road, Watford, Herts.

E8821

TENDERS

FRASERBURGH HARBOUR

8-TON SCOTCH DERRICK CRANE

The Fraserburgh Harbour Commissioners will shortly be inviting TENDERS for the MANUFACTURE and ERECTION of an 8-TON SCOTCH DERRICK CRANE in connection with their improvements at Faithlie Basin.

Experienced firms desiring to Tender are asked to apply before 19th February, 1960, to the Harbour Commissioners' Consulting Engineers, Messrs. Leitch and Sharpe, 65, Bath Street, Glasgow, C.2, from whom further details may be obtained.

The Harbour Commissioners do not bind themselves to accept the lowest or any Tender.

ROBERT SCOTT,
Clerk to the Harbour Commissioners.

E8830

INDIA STORE DEPARTMENT

The Director General, India Store Department, Government Building, Bromyard Avenue, Acton, W.3, invites TENDERS for the Supply of:

TENDER REF. No. 18149/BMB/HAL
BOLSTER SPRINGS—OUTER AND INNER FOR RAILWAY BOGIES.

The Tender forms with Schedules and Specifications which are returnable on 10th March, 1960, may be obtained from the above office (Co-ordination Branch) on payment of a fee of 10s. (not refundable) for each Tender.

Applications for tenders should specify the above reference. E8837

TENDERS

MINISTRY OF TRANSPORT

LONDON-EDINBURGH-THURSO TRUNK ROAD, APEX CORNER, HENDON

The Minister of Transport invites TENDERS for the RECONSTRUCTION of the EXISTING ROUNDABOUT and APPROACH ROADS at Apex Corner, Hendon, Middlesex; the DUPLICATION of the CARRIAGEWAY from Apex Corner to Courtlands Avenue, and the CONSTRUCTION of FOUR PEDESTRIAN SUBWAYS.

Copies of the contract document may be obtained on or after Wednesday, 17th February, 1960, from the Consulting Engineers, Messrs. W. S. Atkins and Partners, 158, Victoria Street, London, S.W.1, on payment of a deposit of £15 by cheque made payable to the Minister of Transport. The deposit will be returned if a bona fide Tender is submitted and not subsequently withdrawn.

Tenders should be sent in a sealed, registered envelope endorsed "Tender for Apex Corner, Hendon," but not bearing any name or mark indicating the sender, addressed to the Assistant Secretary, Ministry of Transport, 21 37, Hereford Road, London, W.2, to arrive not later than 4 p.m. on Wednesday, 30th March, 1960.

The Minister does not bind himself to accept the lowest or any Tender.

H. GILLENDER,
An Assistant Secretary.

E8862

INDIA SUPPLY MISSION

The Office of India Supply Mission, 2536, Massachusetts Avenue, N.W. Washington, 8, D.C., United States of America, invites TENDERS for the following:

TENDER ENQUIRY No. S.E.143

For the Supply of ONE OVERHEAD ELECTRIC TRAVELLING CRANE of 100/20 tons capacity. Span 75ft. approx., required by the Madya Pradesh State Electricity Board, for Amarkantak Thermal Power Station."

Specifications, &c., relative to the above specification, can be obtained from the Co-ordination Branch, India Store Department, Bromyard Avenue, Acton, W.3, at a cost of £1 1s. 5d. per tender, and is not refundable. Tenders are to be returned direct to India Supply Mission, 2536, Massachusetts Avenue, N.W. Washington, 8, D.C., United States of America, so as to reach them by 5th April, 1960.

Specimen copy of the above enquiry can be seen at India Store Department, Engineering Branch, Bromyard Avenue, Acton, W.3, under the following reference: S.3964/59/NSC/ENG.2. E8841

FRASERBURGH HARBOUR

OPENING BRIDGES

The Fraserburgh Harbour Commissioners will shortly be inviting TENDERS for the FABRICATION and ERECTION of TWO OPENING BRIDGES in connection with their proposed improvements at Faithlie Basin. The bridges will be of the traversing type. One bridge, for vehicles, will be electrically operated and will span a 40 foot clear opening. The other will be a hand-operated footbridge spanning a 27 foot skew opening. Experienced firms desiring to Tender are asked to apply, before 19th February, 1960, to the Harbour Commissioners' Consulting Engineers, Messrs. Leitch and Sharpe, 65, Bath Street, Glasgow, C.2, from whom further details may be obtained.

The Harbour Commissioners do not bind themselves to accept the lowest or any Tender.

ROBERT SCOTT,
Clerk to the Harbour Commissioners.

E8829

INDIA STORE DEPARTMENT

The Director General, India Store Department, Bromyard Avenue, Acton, W.3, invites TENDERS for the Supply of:

TENDER REF. No. 18150/59/BMB/HAL
RUBBER BONDED METAL BUFFERS AND STOPS; and AXLE HOLDING RUBBER LININGS.

The Tender Forms with Schedules and Specifications which are returnable on 10th March, 1960, may be ob ained from the above office (Co-ordination Branch) on payment of a fee of 10s. (not refundable) for each Tender.

Applications for Tenders should specify the above reference. E8839

COUNTY BOROUGH OF HALIFAX

ELEVATED STEEL HOPPERS

TENDERS are invited for the SUPPLY and ERECTION at the Sewage Works of ELEVATED STEEL HOPPERS of approximately 2,000 cubic feet total capacity. Specification and General Conditions of Contract may be obtained from the Manager, Sewage Department, Salterhebble, Halifax. Tenders endorsed "S.W. Tender for Steel Hoppers" must be delivered to the Town Clerk, Town Hall, Halifax, by 14th March, 1960. E8880

INDIA STORE DEPARTMENT

The Director General, India Store Department, Government Building, Bromyard Avenue, Acton, W.3, invites TENDERS for the Supply of:

TENDER REF. No. 18155/59/BMB/HAL
800 Sets of SOLID ROLLED OR FORGED STEEL CARRIAGE WHEELS to I.R.S. drawings, and 400 sets of RO GH MACHINED STEEL AXLES FOR RAIL CARRIAGES.

The Tender forms with Schedules and Specifications which are returnable on 10th March, 1960, may be obtained from the above office (Co-ordination Branch) on payment of a fee of 10s. (not refundable) for each Tender.

Applications for Tenders should specify the above reference. E8838

TENDERS

STAFFORDSHIRE POTTERIES WATER BOARD

SHOOTERSHILLS RESERVOIR—CONTRACT NO. 55

The Board invite TENDERS from Civil Engineering Contractors experienced in this class of work for the CONSTRUCTION of a WATERTIGHT REINFORCED CONCRETE RESERVOIR of 2,000,000 gallons capacity in four units of 500,000 gallons at Sandon Road, Near Longton, Stoke-on-Trent.

The Form of Tender, Conditions of Contract, Specification and Bill of Quantities may be obtained from the undersigned on deposit of a cheque for Five Guineas, which will be returned on receipt of a bona-fide Tender not subsequently withdrawn.

Plans of the proposed works may be inspected at the Engineer and Manager's Office.

Two separate Tenders are required:

(1) TENDER with VARIATIONS in Wages and Materials.

(2) TENDER on FIXED PRICE BASIS without any variation being allowed in Wages and Materials.

The two forms of Tender and annexed documents, completed on the alternative basis mentioned above, must be enclosed in the plain envelope provided endorsed "Tender for Shootershills Reservoir," and addressed to the Chairman, Staffordshire Potteries Water Board, c/o Engineer and Manager's Office, Albion Street, Hanley, Stoke-on-Trent, and delivered not later than 12 noon on Monday, 14th March, 1960. The envelope must not bear any name or mark indicating the sender. At the same time copies of the completely priced Bills of Quantities for each of the alternative basis mentioned above must be delivered in one separate sealed envelope, similarly addressed, within the same time. This sealed envelope must be endorsed "Priced Bills for Shootershills Reservoir" and bear the Tenderer's name.

Tenders which do not comply with the above requirements will not be considered.

The Board do not bind themselves to accept the lowest or any Tender.

C. V. BROWN.
M.I.C.E., M.I.Mech.E., M.I.W.E.,
Engineer and Manager and Clerk.

Albion Street,
Hanley, Stoke-on-Trent. E8871

INDIA SUPPLY MISSION

The Office of India Supply Mission, 2536, Massachusetts Avenue, N.W., Washington, 8, D.C., United States of America, invites TENDERS for the following:

TENDER ENQUIRY No. SE.133

For the Supply of the following:

Group No.		Description
1	...	Operating Equipment, Pumping Sets, Portable Generating Sets.
2	...	Skid Mounted Diamond Core Drills.
3	...	Diamond Bits and Reaming Shells.

Specifications, &c., relative to the above specification, can be obtained from the Co-ordination Branch, India Store Department, Bromyard Avenue, Acton, W.3, at a cost of £1 1s. 5d. per tender, and is not refundable. Tenders are to be returned direct to India Supply Mission, 2536, Massachusetts Avenue, N.W. Washington, 8, D.C., United States of America, so as to reach them by 15th March, 1960.

Specimen copy of the above enquiry can be seen at India Store Department, Engineering Branch, Bromyard Avenue, Acton, W.3, under the following reference S.4052/59/NSC/ENG.2. E8840

COQUET WATER BOARD

FLOW METERING EQUIPMENT

CONTRACT NO. 16

TENDERS are invited for the SUPPLY, DELIVERY and INSTALLATION at the several sites of all or any of the following FLOW METERING EQUIPMENT:

(i) One Recorder and Transmitter for use in connection with a standing wave flume.
(ii) One Rectangular Compound Weir with Recorder and Transmitter.
(iii) One Rectangular Weir with Recorder and Transmitter.
(iv) Eight Differential Pressure Measuring Devices for incorporation in pipelines of Sizes 36in., 30in., 24in. and 18in. diameters, together with Recorders and Transmitters.
(v) Two Mechanical Meters.
(vi) One Instrument Panel.
(vii) Ancillary equipment for the above.

Forms of Tender, specifications and drawings, may be obtained from Mr. S. G. Barrett, M.I.C.E., Engineer and Manager of The Coquet Water Board, P.O. Box 104, Pilgrim Street, Newcastle upon Tyne, 1. Tenders are to be returned in envelope provided, to the undersigned, not later than 10 a.m. on 14th March 1960.

The Board do not bind themselves to accept the lowest or any Tender and reserve the right to accept the whole or part of any Tender received.

F. G. EGNER,
Clerk and Solicitor to the Board.

14, Northumberland Square,
North Shields. E8834

INDIA STORE DEPARTMENT

The Director General, India Store Department, Government Building, Bromyard Avenue, Acton, W.3, invites TENDERS for the Supply of:

TENDER REF. No. 18151/59/BMB/HAL
3200 off RUBBER-METAL FLEXIBLE MOUNTINGS of various sizes for Railway Bogies.

The Tender forms with Schedules and Specifications which are returnable on 10th March, 1960, may be obtained from the above office (Co-ordination branch) on payment of a fee of 10s. (not refundable) for each tender.

Applications for Tenders should specify the above reference. E8836

EDUCATIONAL

COLLEGE OF AERONAUTICS

ONE-YEAR POST-GRADUATE COURSE IN THE PHYSICS AND MECHANICS OF STRUCTURAL MATERIALS 1960-1961

Applications are invited for the ONE-YEAR COURSE which begins on 10th October, 1960. Prospective students must be of Graduate status in an appropriate branch of science or engineering and must have practical experience in one of the fields covered by the course.

The purpose of the course is to give instruction in the analytical methods of the theories of elasticity and plasticity and in the basic theories of the nature of materials derived from the sciences of physics, chemistry and metallurgy.

Students who complete the course satisfactorily will be awarded the Diploma in Advanced Engineering (D.A.E.).

Further information and forms of application may be obtained from: The Warden, The College of Aeronautics, Cranfield, Bletchley, Bucks. E8796 B

EDUCATIONAL

NORTHAMPTON COLLEGE, LONDON

SHORT COURSE ON NUCLEAR POWER PLANT DESIGN

A SHORT COURSE intended for Engineers and Scientists employed on NUCLEAR POWER PLANT DESIGN will be held at the College from Monday, 2nd May, to Friday, 13th May, 1960. Lecturers will be drawn from industrial groups concerned in this field of engineering.

Particulars and application forms from the Secretary, St. John Street, London, E.C.1. E8858 B

A.M.I.MECH.E., B.Sc., City and Guilds, etc. Guarantee Postal Courses for all Exams. and Technical Divisions from Elementary to Degree standard including Automation Techniques. Approximately 95 per cent successes. 148-page prospectus free, on request.—B.I.E.T. (Dept. 22) 29, Wright's Lane, London, W.8. F114 B

TRAIN FOR A CAREER IN TEACHING ENGINEERING SUBJECTS

Persons aged between about 25 and about 45, with good industrial experience, are invited to apply for training as **FULL TIME TEACHERS OF ENGINEERING SUBJECTS IN TECHNICAL COLLEGES AND SCHOOLS.**

EXCELLENT CAREER PROSPECTS

NEXT COURSE: SEPTEMBER 1960, TO JUNE 1961

Applicants should hold suitable qualifications, e.g. a university degree, associate or graduate membership of a professional institution, Higher National Certificate, Final or Full Technological Certificate of the City and Guilds of London Institute.

NO TUITION FEES

PERSONAL, MAINTENANCE, DEPENDANTS' AND TRAVELLING GRANTS PAYABLE

For details write immediately, quoting S/36 to either

The Director, Bolton Training College, Manchester Road, Bolton.
The Director, Huddersfield Training College, Holly Bank Road, Huddersfield.
The Principal, Garnet College, 83 New Kent Road, London S.E.1.

E8728 B

BOOKS and PUBLICATIONS

For all users, buyers and designers of Iron Castings

NEW

The Ironfoundry Handbook

42s. net.

1st Edition

A new 400-page book, published to assist Designers and Manufacturers using castings in their own work. This handbook is a guide to the facilities, capabilities and capacities of individual Foundries, enabling users to contact a suitable foundry for specific types of work.

A great deal of work and research has been undertaken in an effort to make this publication as comprehensive as possible. It includes an alphabetical register of Ironfounders broken down in regional areas giving full details of each firm and a sectional list of work undertaken by each foundry, listed in an alphabetical register. Foundries are listed under eleven separate headings, according to the types of work undertaken, i.e. Malleable Iron Castings, Machinery Castings, Automobile Industry Castings, etc.

To: The Standard Catalogue Co., Ltd., 20, Bloomsbury Way, London, W.C.1.

Please supply.....copies of the Ironfoundry Handbook and send invoice to:

Name .....

Address .....

Enter No. 1211 on reply card

EDUCATIONAL

COLLEGE OF AERONAUTICS

ONE-YEAR POST-GRADUATE COURSE IN FLUID MECHANICS 1960-61

A ONE-YEAR POST-GRADUATE COURSE in "FLUID MECHANICS" will be held at the College during the Autumn, Spring and Summer terms of the academic year 1960–61.

The course is intended for students wishing to acquire a knowledge of fluid mechanics at an advanced level without necessarily specialising in aeronautics. Applicants must be Graduates in a branch of science or engineering and have had practical experience in one of the subjects covered by the course.

The content of the course includes the general theory of fluid flow at subsonic, supersonic and hypersonic speeds, high temperature gas dynamics and hydromagnetics, project work, experimental facilities and techniques and specialised aspects of ship hydrodynamics (including cavity flows, behaviour of ships at sea and high-powered ship propulsion) and mathematics.

Students who complete the course satisfactorily will be awarded the Diploma in Advanced Engineering (D.A.E.).

Further information and forms of application may be obtained from the Warden, The College of Aeronautics, Cranfield, Bletchley, Bucks. E8795 B

SITUATIONS VACANT

APPLICANTS ARE ADVISED TO SEND COPIES NOT ORIGINALS OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED.

A MECHANICAL ENGINEER is required to design and build experimental test rigs mainly for use at low temperatures. The work involves very close collaboration with Chemists, Chemical Engineers and Physicists, who will be using the rigs. Applications are invited from Graduates or candidates with equivalent qualifications who should write to the Secretary, British Oxygen Research and Development, Ltd., Deer Park Road, London, S.W.19. E8800 A

A VACANCY EXISTS FOR AN ASSISTANT ENGINEER within the Engineering Department of LAPORTE CHEMICALS LIMITED, LUTON. Applications are invited from men, age about 30 years, who have served a 5-year mechanical engineering apprenticeship and, preferably, have had some experience in works maintenance generally, but shop work in particular, and have obtained an H.N.C. (Mechanics) or equivalent qualification. Experience in preventive maintenance and an appreciation of work study would be an advantage. Salary according to qualifications and experience.—Applications, giving details of age, qualifications and experience, and quoting ref. LCL/TE1/10 should be addressed to the Group Personnel Manager, LAPORTE INDUSTRIES LIMITED, Hanover House, 14, Hanover Square, London, W.1. E8870 A

A.E.R.E.
HARWELL
REACTOR SERVICES
A PROFESSIONAL ENGINEER

is required for the

MAINTENANCE SECTION, which covers all maintenance aspects of research reactors and ancillary equipment within the REACTOR SERVICES GROUP.

Applicants should have experience of maintenance in electrical, electronic and mechanical engineering fields. Experience of installation work, testing and commissioning of new and prototype equipment, would be an advantage.

Salary: £1370–£1825 p.a.
Housing and superannuation schemes.
Send POST CARD to the Group Recruitment Officer (1561/25), U.K.A.E.A., A.E.R.E., Harwell, Didcot, Berks. E8809 A

APPLICATIONS ARE INVITED from ambitious and resourceful men to fill the position of TECHNICAL ASSISTANT to the Sales Manager of Electric Lamp Machinery Manufacturers near London. A permanent, progressive and interesting job is offered to the right person, who must possess a sound engineering and commercial background in the trade.—Applications, with full particulars of education, experience and salary required, to BOX No. E171, "The Engineer." A

ASSISTANT WORK STUDY OFFICER

Candidates, who should possess a sound engineering background, must be experienced in work measurement and method investigation and fully conversant with latest techniques. A thorough knowledge of process charting is required. The location will be within the Birmingham area.

The salary for the appointment, which is pensionable and subject to medical examination, will be within £1155–£1235 per annum.

Applications, stating age, qualifications and full details of experience, together with the names of two referees, should be addressed to the Industrial Relations Officer, West Midlands Gas Board, 6, Augustus Road, Edgbaston, Birmingham, 15, to reach him not later than the 22nd February, 1960. E8865 A

B.B.C. requires ENGINEER for Aerial Unit, Planning and Installation Department in London, to undertake stress analysis and deal with structural problems arising in design of radio aerial systems. Candidates should be trained structural engineers, preferably with qualifications satisfying examination regulations of Institution of Civil Engineers or Institution of Structural Engineers. They must be physically fit and able to ascend structures up to 1000ft. above ground. Successful candidate will be required to undergo medical examination. Preference to candidates with three or more years' experience in design of steel structures similar to those used for supporting high power V.H.F. transmitting aerials. Knowledge of basic electrical principles of aerial systems advantageous. Salary in scale £1230 with annual increments to maximum of £1580 per annum. —Requests for application forms to Engineering Recruitment Officer, Broadcasting House, London, W.1, quoting ref. 60.E.12.Eng. E8812 A

SITUATIONS VACANT

BOWATER-EBURITE BULK PACKAGING LIMITED, Multiwall Sack Division, Ellesmere Port, Wirral, Cheshire, have vacancies for TWO PROJECT ENGINEERS with experience in research and development in the light and medium engineering fields for work on machinery investigation design, development and manufacture in the paper converting industry. Applicants should be of H.N.C. (Mechanical) standard and have wide experience of engineering and scientific development, preferably with a good engineering apprenticeship.—Applications, giving full particulars of experience and present salary, should be addressed to the Development Engineer and marked "Confidential." E8813 A

CENTRALUBE, LTD., Lubrication Engineers, require the following Mechanical Engineers, preferably qualified, with heavy Engineering and/or sales experience: PERSONAL ASSISTANT to Chief Engineer, based at Head Office, London. AREA ENGINEERS for Scottish and Yorkshire Areas. ENGINEERS for London Office, N.18.—Full details of age, experience and salary required, in confidence to Managing Director, Centralube, Ltd., Park Royal Road, London, N.W.10. E8735 A

CHARTERED CIVIL ENGINEER required as Manager of expanding Department in a Contracting Company with international interests. Previous experience in office administration and estimating for and supervision of civil engineering contracts essential. This is an opportunity for a well-trained man, preferably a University Graduate, to build up a worth-while permanent career in an established company based in the provinces, with possibilities of a Directorship in due course. A substantial salary, bonus on results, expenses, car allowance and a pension scheme will be offered, along with a company house at moderate rental and removal expenses. Candidates for this post are invited to apply in own handwriting (in confidence) for further particulars; also submitting a précis of their education, experience, availability, marital status and basic salary requirement, pending possible further enquiry from and interview with the advertisers.—BOX No. E8878, "The Engineer." A

DESIGN ENGINEERS AND DESIGNER DRAUGHTSMEN, with up to seven years' experience in design of heavy reinforced concrete, steel and concrete structures, &c., wanted by Sir William Halcrow and Partners, Alliance House, Caxton Street, London, S.W.1. E8873 A

DESIGN FOR LIVING.—At Duramin we have a real engineering job on hand, designing and building quality bodywork for a wide range of specialised commercial vehicles for home and export. If you have had practical and theoretical engineer's training and can wield a pencil and want a worthwhile post as leading or intermediate DESIGNER/DRAUGHTSMAN, write to me in confidence to-day. Initiative, ability and hard work will be recognised. We are enthusiastic and growing fast and conditions are excellent in our fine modern offices.—Apply, Production Director, Duramin Engineering Co., Ltd., Stonefield Way, Ruislip, Middlesex. E2715 A

DESIGNER DRAUGHTSMAN.—Vacancy for Draughtsman aged 28–35, with National Certificate in Mechanical Engineering and works training, also design experience in general mechanical engineering or in some of the following: chemical and process plant, refrigeration, mechanical handling plant, services, and plant layout. Excellent amenities, five day week, three weeks' holiday, non-contributory pension scheme. Commencing salary within the range £930–£1100 per annum.—Apply in writing, giving full details, to Personnel Manager, Arthur Guinness Son and Co. (Park Royal), Ltd., London, N.W.10. Ref. DRA/TE. E8724 A

DRAUGHTSMAN MECHANICAL (SENIOR) required by the British Drug Houses, Ltd. for layout and special machine developments in their chemical laboratories. H.N.C. or equivalent preferred. Five-day week, Canteen, Sports Club, Pension and Profit Sharing Schemes.—Apply in writing, stating age and educational attainments to the Staff Manager, Graham Street, City Road, N.1. E8743 A

ENGINEER required to assist Chief Mechanical Engineer. Age 25–35, preferably with experience in iron or steel works. A recognised qualification is desirable. The post is superannuated.—Apply in writing, giving full details and qualifications, to Labour and Welfare Officer, Staveley Iron and Chemical Company Limited, Near Chesterfield. E8875 A

ENGINEER (MECHANICAL).—Applications are invited from Engineers not over 35 years, who possess 1st Class M.O.T. Certificates (Steam). Willing to reside in or near London for duties in that area and to undertake three-monthly tours of inspections of boilers, pressure vessels, &c., in West Africa. Salary in accordance with age, previous experience, if any, plus expenses and allowances. Non-contributory pension scheme. Apply in own handwriting.—BOX No. E8820, "The Engineer." A

ENGINEERS, CIVIL and MECHANICAL—temporary—required by Iron Ore Mining Company, for one tour of approximately 18 months' duty in BRITISH WEST AFRICA. Civil Engineer to supervise foundation and steelwork contracts, and Mechanical Engineer to supervise installation of plant and machinery, including electrics, in an ore concentrating plant. Engineers with previous experience contract supervision essential. Salary, £1900 per annum, plus bonus plus for married man, marriage allowance at the rate of £10 per month and children's allowance at the rate of £5 per month for each child under 18. Dependant's Income Scheme and free life assurance. Return passage paid. Initial kit allowance. Free furnished accommodation and medical attention.—Write, giving full details of experience, stating age, married or single, to SIERRA LEONE DEVELOPMENT CO., LTD., Dept. M.P.7, City Gate House, Finsbury Square, London, E.C.2. E8902 A

ENGINEERING DRAUGHTSMAN

required by the National Coal Board in London. Applicants should have knowledge of heavy mechanical engineering; experience of mining machinery or mechanical handling equipment would be an advantage. O.N.C. or equivalent qualification is required. Appointment superannuable salary according to qualifications and experience, within £805–£930.—Write for application form to Staff Department (X1678B.), N.C.B., Hobart House, London, S.W.1, before 22nd February, 1960. E8823 A

Classified Advts. continued on page 122

SITUATIONS VACANT

GEAR ESTIMATOR required, capable of calculating and preparing quotations for Reduction Gear Units, Gears, &c., for Industrial Drives.—Apply, giving full details, to Alfred Wiseman and Co., Ltd., Glover Street, Birmingham, 9. E8845 A

INDUSTRIAL GAS REPRESENTATIVES

With the increase in the development and utilisation of gas for Industrial purposes, further appointments are being made in the Midlands to meet the demand.

The work will involve investigation and submission of schemes for the use of gas for furnace heating and other industrial purposes.

Applications are invited from candidates with an appropriate university degree or similar qualification. Experience of Industrial Gas is not essential as adequate training will be given.

The salary during the training period will be within the range of £733–£813 per annum, and subject to satisfactory completion of training, appointment to a permanent post on a higher grade will be made. The appointments are pensionable and subject to medical examination.

Applications, stating age, education, qualifications and experience, should be addressed to the Industrial Relations Officer, West Midlands Gas Board, 6, Augustus Road, Edgbaston, Birmingham, 15.

E8801 A

MACHINERY AND INSTRUMENTS DEPARTMENT MANAGER required by London Export Merchants. Qualifications desired are previous merchanting and export experience, good negotiating ability, and sufficient technical knowledge of products to facilitate the handling of business. Good salary and prospects, together with pension scheme, make this an excellent opportunity for energetic man. Apply in confidence.—BOX No. E2714, "The Engineer." A

MAJOR INDUSTRIAL COMPANY requires an ENGINEER at one of its North London Works. Applicants should have a good engineering background and preferably some experience in development work in a Process Industry. He will act as an Assistant to the Engineering Manager and would be required to work both on new projects and modification of existing plant. Minimum qualification of Higher National Certificate and the age range is 24–30; an attractive commencing salary and there are bright prospects for the future. Please reply.—BOX No. E8879, "The Engineer." A

MECHANICAL ENGINEER required by leading British merchant company, with Head office in London, for its branch in South India, where it owns a large engineering works. The duties are concerned with sales and engineering aspects of a wide range of plantation equipment. Applicants should be single, under 30, and Graduate or Associate Members of the Institution of Mechanical Engineers. Full details of remuneration, housing, leave, medical scheme, retirement and other benefits will be supplied at interview.—BOX No. E8855, "The Engineer." A

PILKINGTON BROTHERS LIMITED, Sheet Works, have vacancies in their Drawing Offices for MECHANICAL DRAUGHTSMAN. Applicants should have had experience in plant layout and machine design and should have a Higher National Certificate in Mechanical Engineering or be working for it. Assistance with house purchase, recreational and canteen facilities, five-day week, superannuation scheme.—Applications should be addressed to the Personnel Officer, Pilkington Brothers Limited, Sheet Works, St. Helens, Lancashire. E8819 A

QUALIFIED CIVIL ENGINEER required for position of Resident Engineer in charge of Airport buildings and constructional work in West Africa. The appointment will be for 3 years subject to home leave.—Applicants to forward particulars of training and experience by 7th March, 1960, to Norman & Dawbarn 7, Portland Place, W.1.

E2710 A

RICHARD SUTCLIFFE LIMITED

Owing to expansion in our Development Department, we require:—

TWO GRADUATE DEVELOPMENT ENGINEERS AND TWO DEVELOPMENT DESIGN ENGINEERS

GRADUATE DEVELOPMENT ENGINEER (INDUSTRIAL)

Applicants should preferably be between 30 and 35 years of age, have graduated in Mechanical Engineering, have experience of high-speed rotating machinery and mechanical handling equipment for bulk materials.

GRADUATE DEVELOPMENT ENGINEER (MINING)

Applicants should preferably be between 25 and 30 years of age, have graduated in Mining Engineering and have completed a further year's study in Mechanical Engineering. Experience in the development of mining machinery, especially of rock drilling and allied equipment, would be an advantage.

DEVELOPMENT DESIGN ENGINEERS

Applicants should preferably be between 28 and 35 years of age, must have passed Higher National Certificate in Mechanical Engineering or its equivalent, and have experience of at least one of the following: drilling machinery, high-speed rotating machinery, gear boxes, presses or hydraulic equipment.

These are interesting and progressive appointments involving the improvement of existing products and the development of new.

Salaries will be on a generous scale, commensurate with qualifications and experience, and will be supplemented by a contributory pension scheme.

Applications, which will be treated in confidence, should set out chronologically full details of education, technical training, experience and the usual personal information, and should be addressed to the Personnel Manager, Universal Works, Horbury, Near Wakefield.

E8868 A

RESIDENT ENGINEER (CIVIL) required for heavy industrial foundation work in Midlands. Must have had similar previous experience. Apply in confidence, giving age, details of experience, when available and salary required.—BOX No. E8825, "The Engineer." A

REQUIRED BY CONSULTING ENGINEERS, Qualified CIVIL ENGINEERS between the ages of 26 and 35, with experience of water supply or hydro-electric schemes for design work in London.—Apply in writing, giving details of education, technical qualifications and experience, to Binnie, Deacon and Gourley, Artillery House, Artillery Row, London, S.W.1. E8804 A

SENIOR ENGINEER required to take charge of building services design teams. Candidates to be thoroughly experienced in all aspects of building services work, particularly in the design of heating, ventilating and electrical services. Minimum qualification Associate Membership of the Mechanical or Electrical Institutions. The successful candidate will be considered for the position of Associate with this firm.—Applications giving age, experience and salary required to Norman and Dawbarn, Architects & Consulting Engineers, 7, Portland Place, W.1. E2709 A

SERVICES ENGINEER required for a chemical factory, preferably with experience of water-tube and Lancashire boilers, refrigeration, compressed air, water filtration and distribution. Must have enthusiasm and initiative for planning a services development scheme. The post is permanent and offers opportunity for the right man.—Apply to Chief Engineer, Messrs. HICKSON & WELCH LIMITED, Ings Lane, Castleford, Yorkshire. E8846 A

TECHNICAL SALES ENGINEER, preferably with experience of tube and rod drawbenches, similar heavy metal-working equipment and preferably resident Midlands, to represent London firm manufacturing heavy American equipment under licence. Existing connection with users of this type of equipment an advantage. Write, stating qualifications, experience, age, &c.—BOX No. E8861, "The Engineer." A

TECHNICAL SALES REPRESENTATIVE for London area required by Glasgow Company manufacturing capital equipment for process industries, including Chemical, Plastics, Food Processing and Textile Industries. Must be a trained Engineer with practical experience and able to negotiate large contracts with top executives. Good pension scheme. Car provided.—BOX No. E2716, "The Engineer." A

THE BURMAH OIL COMPANY (PIPE LINES) LTD.

invites applications for the following appointments in connection with the construction of a major crude oil pipeline in India.

QUALIFIED CIVIL ENGINEER with previous experience of deep excavation in waterlogged ground and with knowledge of draglines, dredging and dewatering equipment.

QUALIFIED STRUCTURAL ENGINEER with experience of field erection of steel structures.

Salaries, paid in Rupees and free of Indian Taxation, will be related to qualifications and experience, and free single accommodation and messing will be provided.

Replies, giving full details of experience and personal particulars, to: The Burmah Oil Co. (PIPE LINES) Ltd., Britannic House, Finsbury Circus, London, E.C.2.

E8853 A

WANTED, FIRST-CLASS SENIOR DESIGN DRAUGHTSMAN for firm of General Engineers in Bristol. Good knowledge of general engineering, with particular reference to pressure vessels and stainless steel fabrication. This will be a well-paid position for the top-class man.—BOX No. E164, "The Engineer." A

WORKS MANAGER with knowledge of tube manufacture. Must have wide experience in practical and executive appointments, held similar positions and be a first-class administrator. Substantial salary will be paid to man with necessary qualifications, and future prospects are excellent.—Apply in confidence to the Managing Director, The Phoenix Steel Tube Co., Ltd., Phoenix Street, West Bromwich. E8644 A

YOUNG SALES ENGINEER required by Importers of Continental Machines for Woodworking and Plastics Industry. Previous sales experience not essential but knowledge of German advantageous.—BOX No. E2696, "The Engineer." A

SENIOR DRAUGHTSMEN

experienced in bulk mechanical handling or foundry work. Superannuation Scheme. Five-day week. Apply to MARCO CONVEYOR & ENGINEERING COMPANY Ltd., Lynn Road, Leytonstone, London, E.11. LEY 2254.

E8805 A

INSTRUMENT DRAUGHTSMAN for SOUTH AFRICA

African Explosives and Chemical Industries, Ltd., has a vacancy for a Detail or Design Instrument Draughtsman at its Modderfontein Factory, nr. Johannesburg. Qualification: O.N.C., preferably H.N.C., and minimum 2 years' drawing-office experience. Single men preferred.

Conditions include 3 year initial contract with payment of passage and expense allowance, guaranteed accommodation, membership of Pension Fund and Medical Aid Society. Emoluments include Cost-of-Living Allowance, annual Bonus and regular increments for satisfactory work.

Apply to:

L. H. F. Sanderson,
Overseas Recruitment Officer,
A.E. and C.I. Limited,
Imperial Chemical House,
London, S.W.1.

E8816 A

THE DISTILLERS COMPANY LIMITED

SENIOR ESTIMATOR (MALE)

The Distillers Company Limited has a vacancy in its Engineering Division in the West End of London for a Senior Estimator. The post calls for considerable and varied experience in estimating construction costs of chemical plant projects including buildings, steelwork, off-site services and associated equipment, and will carry a four figure salary. Candidates should be over 35 years of age, with adequate engineering training and a recognised qualification in engineering is desirable.

Write:
STAFF MANAGER,
THE DISTILLERS COMPANY LIMITED
21–22, BOLTON STREET,
LONDON, W.1.

Quote Ref.: 12/60 TE.

E8810 A

DRAUGHTSMEN

are required by Saunders Valve Company, Limited, Blackfriars Street, Hereford.

The vacancies are for qualified Draughtsmen with experience in Tool Design, Planning Layouts and Die and Shell Mould design for aluminium castings.

Salary will be commensurate with ability and experience. Age 25 upwards.

Contributory pension scheme, 5-day week.

Apply in writing, giving full particulars of age, education and experience, in confidence, to Chief Engineer at the above address.

E8833 A

THE ASSOCIATED PORTLAND CEMENT MANUFACTURERS LIMITED

require several

SENIOR AND JUNIOR MECHANICAL ENGINEERING DRAUGHTSMEN

for work on plant layout schemes and details at Head Office, Westminster.

Experience in heavy machinery plant layout and mechanical handling an advantage. Applicants with H.N.C. in Mechanical Engineering preferred for Senior Posts.

The Company offers good salaries and working conditions, pension fund and profit-sharing bonus.

Replies, giving particulars of training and experience, will be treated in full confidence and should be sent to the following, marked "Personal":—

The Manager,
Central Engineering Department,
Associated Portland Cement Manufacturers Ltd.,
Portland House, Tothill Street, LONDON, S.W.1.

E8664 A

JOHNSON, MATTHEY & CO., LIMITED

have a few vacancies for young men in their engineering factories near London, who wish to make a career in Production Management.

Candidates, who should be between 25 and 30, should preferably have had a recognised engineering apprenticeship and an H.N.C. in Production Engineering. Preference will be given to candidates with some experience of production control in light engineering.—Write, giving full details of qualifications, experience, age, &c., to the Secretary of the Company, 78, Hatton Garden, London, E.C.1.

E8811 A

SENIOR DEVELOPMENT ENGINEER

(Heat Exchange)

for a long-established and important engineering company in the Manchester area. The commencing salary will be £1500 p.a., with considerable prospects of improvement, together with pension scheme.

The problems of heat exchange are involved in a very large part of the Company's products. The Senior Development Engineer will, amongst other things, guide the Drawing Offices on structural design of all orders received and liaise with Works Management on the engineering aspects of manufacture of all heat exchangers. He will also be in close touch with the market and draw up specifications for new ranges of heat exchangers and/or modifications to existing ranges, having in mind competition and cost of manufacture.

The Company's equipment is up to date and working conditions are highly congenial from all points of view.

Qualifications should include a sound theoretical knowledge, preferably A.M.I.Mech.E.; protracted shop floor experience; appreciation of inter-relation of design and cost of manufacture; a strong commercial sense of the product. Age 30–40.

Please write in first instance, quoting Reference No. 615, to:—

AA LTD

ASHLEY ASSOCIATES LTD.
PETER HOUSE, MANCHESTER 1.
RETAINED TO ADVISE ON THIS APPOINTMENT
The strictest confidence will be observed and no details of candidates will be passed to clients without candidates' permission.

E8856 A

SITUATIONS VACANT

Leading Midland Machine Tool Company have a vacancy for a

SALESMAN

to specialise in the sale of high grade heavy machine tools. Good engineering training essential. Knowledge of steel industry an asset. Responsibilities include travelling the whole of the country and occasionally abroad. A car will be provided and there is an attractive pension scheme. Good basic salary and commission.—Applications, giving full details of past experience together with age and salary expected to BOX No. E8736, "The Engineer."

A

SITUATIONS VACANT

BRITISH CONSTRUCTIONAL STEELWORK ASSOCIATION

Applications are invited for appointments to the DEVELOPMENT STAFF and to the BRIDGE DEPARTMENT.

Candidates should be young men with some experience in the design and detailing of steel frame buildings with knowledge of B.S.449 or with experience in the design of steel bridges with knowledge of B.S.153. Five-day week and luncheon vouchers. Admission to non-contributory pension scheme after qualifying period.

Apply in confidence to the Technical Adviser, British Constructional Steelwork Association, Artillery House, Artillery Row, London, S.W.1, giving fullest details with salary required.

E8675 A

SITUATIONS VACANT

NUCLEAR ENGINEERING

SENIOR DESIGN ENGINEER required to lead a small team engaged in the design of novel steam generator and heat exchanger equipment, associated with advanced types of nuclear reactors and other novel plant in the steam power and propulsion field. Applicants should hold a mechanical or chemical engineering degree and should have had previous experience in all aspects of heat exchanger design, and of plant operating at high pressure.

Commencing salary in range £1200–£1450 per annum, according to experience. Contributory Pension Scheme.

Applications should be made in writing, giving details of age, qualifications and experience, to :

Staff Manager,
FOSTER WHEELER LIMITED,
3, Ixworth Place,
LONDON, S.W.3.

E8789 A

SITUATIONS VACANT

BUILDING SURVEYOR/ESTIMATOR

required by

W. H. ALLEN SONS & CO., LTD., BEDFORD

The successful applicant will be responsible to the Works Engineer for the introduction and, later, operation and financial administration of a Progressive Building Maintenance Scheme.

Age should be between 25–35 years and qualifications should include, for preference, A.R.I.C.S.

The Company has an excellent Pension and Life Assurance Scheme in operation and offers good working conditions and welfare amenities. Assistance will be given towards moving expenses.

Applications, in writing, stating details of past experience and present salary, should be forwarded to the

PERSONNEL MANAGER,
(quoting reference No. 1602/C9).

E8734 A

FRANCIS SHAW AND COMPANY LIMITED

require

A PRODUCTION MANAGER

30 to 40 years of age, to take charge of overall planning and progressing production for works engaged in the manufacturing of medium/heavy machinery for the rubber and plastics trades and employing approximately 750 persons. Candidates must have attained a position of responsibility in a substantial manufacturing organisation and have expert knowledge of production control, including punched card systems, and will be responsible for compiling and maintaining delivery schedules. Mechanical Engineering apprenticeship with a Professional qualification is preferable. The suitable applicant will be responsible to the Works Director.

AN ASSISTANT TO THE WORKS DIRECTOR

30 to 40 years of age, who will assist in controlling the practical activities of a works employing approximately 750 persons and manufacturing medium/heavy machinery for the rubber and plastics trades. The successful candidate must have a thorough knowledge of the latest tooling methods and must have served in a position of responsibility in a substantial manufacturing organisation. A Mechanical Engineering apprenticeship is essential and a Professional qualification preferable.

A generous non-contributory pension scheme is in operation for each of these appointments.

Applications, which will be treated in confidence, should give fullest information and salary required, and be addressed to the Secretary, Corbett Street, Manchester, 11.

E8826 A

LAING

MECHANICAL DESIGN ENGINEERS

The following vacancies exist in the Laing group of Companies. The work is of an interesting nature and concerned with the development of new machines and processes connected with the Building and Civil Engineering Industries.

SENIOR DESIGNER

required with experience in factory layout and factory machinery, for THERMALITE YTONG LIMITED. The work will involve the development of equipment for the production of high-class building components. A.M.I.Mech.E. qualifications, with experience in Mechanical Handling, required.

SENIOR DESIGNERS

for the Research and Development Centre of John Laing and Son Limited at Boreham Wood. Applicants should be of A.M.I. Mech.E. standard and have experience in the development of new and improved types of CONTRACTORS' PLANT.

ASSISTANTS

to the above are required of H.N.C. or Graduate level, some experience required.

GRADUATE MECHANICAL & CIVIL ENGINEERS

with Site experience in the operation of contractors Plant, for work involving the study, performance and development of the mechanisation techniques applied within the Contracting Industries.

All these posts are permanent and progressive. Pension Scheme.

Applicants should write in the first instance to :—

Personnel Manager (Ref. M.D.E.I)
John Laing and Son (Holdings) Limited,
Page Street, N.W.7.

E8738 A

VICKERS-ARMSTRONGS (ENGINEERS) LIMITED

Applications are invited for the following posts, in connection with work in Barrow-in-Furness or Dounreay, Scotland.

MECHANICAL ENGINEERS (*Barrow only*)

(*a*) An honours graduate to assist in running a department concerned with feasibility studies, the mathematical solution of design problems, together with the execution and analysis of basic experimental research in connection with marine propulsion.
(*b*) Several graduates possessing either ordinary or honours degrees to carry out work as outlined above.
(*c*) Men with good H.N.C.'s and exceptional experience in the theory and practice of some branch of heavy engineering, to assist in work as outlined above.

The work of the department is very interesting and covers an extremely wide field. Previous training in Reactor Engineering will be an advantage, but is not essential, since arrangements will be made for training where necessary.

ELECTRICAL ENGINEER

(*Senior Appointment, Barrow only*)

to be responsible for the operation of all electrical machinery associated with a Prototype Naval Reactor and capable of advising on electrical matters.
Candidates should preferably have had Marine Experience and hold a University Degree, though exceptional men with H.N.C. would be considered. They should be members of the Institution of Electrical Engineers, or have the necessary theoretical and practical qualifications for membership.
Recent experience is desirable in the design and operation of heavy A.C. and D.C. rotating machinery, together with associated switchgear, control and distribution systems.
Arrangements will be made for the successful candidate to receive adequate specialised training.

SHIFT SUPERVISORS (*Senior Appointment*)

having Degrees in Mechanical Engineering and either land-based or seagoing experience in operating steam machinery. Previous training in Reactor Engineering will be an advantage but is not essential, since arrangements for training will be made where necessary.

ELECTRONIC ENGINEER (*Senior Appointment*)

Having a University Degree and industrial experience for work on Marine Installations associated with Naval Reactor Plant.
Previous Nuclear Experience is desirable.

OPERATING ENGINEER

preferably with a Degree in Mechanical Engineering and either land-based or seagoing experience in operating steam machinery. Previous training in Reactor Engineering will be an advantage but is not essential, since arrangements will be made for training where necessary.

TEST ENGINEERS

are required having a good theoretical knowledge and a background of seagoing or other approved power plant experience. They should be capable of analysing test results arising from the operation of conventional steam machinery, and of writing coherent reports on their work.
H.N.C. is the minimum acceptable technical standard.

DESIGN ENGINEERS AND ENGINEERING DESIGNERS (*Barrow only*)

required with either a Degree or H.N.C. with distinction in Mechanical Engineering, for work on Nuclear Power Plants for Marine Propulsion.
Candidates, who should have had at least two years in a Drawing Office, must be capable of working on their own initiative.
Previous design experience in Marine Propulsion would be an advantage.

ELECTRONIC TECHNICIANS AND TROUBLE SHOOTERS (*Staff Appointments*)

capable of diagnosing and rectifying faults in the instrumentation and electronic control gear associated with a Prototype Naval Reactor.
Candidates should have had previous industrial experience.
A knowledge of magnetic amplifiers will be an advantage.
Training Courses in Reactor Instrumentation will be arranged where necessary.

DRAUGHTSMEN (*Barrow only*)

possessing a minimum qualification of O.N.C., but preferably H.N.C. Men are wanted with experience in engine room layout, pipework and in the production of detail designs and drawings.
There is a generous additional allowance for successful applicants who are required for duties at Dounreay.
Applications giving details of past experience, present work, responsibility and salary currently received should be addressed to :

The Manager, Marine Propulsion, Research and Development,
VICKERS-ARMSTRONGS (ENGINEERS), LIMITED,
Naval Construction Works, Barrow-in-Furness, Lancashire.

E8806 A

MECHANICAL EQUIPMENT ENGINEER

required by leading contractors to the Chemical and Petroleum Industry.

Applicants should have first-class experience of Pumps, Compressors and Reciprocating Machinery of all types and be of A.M.I.Mech.E. standard.

SALARY IN THE REGION OF
£1,750 P.A.

Applications, which will be treated in strict confidence, should give full details of age and experience &c., to BOX No. E8722, "The Engineer."

A

Classified Advts. continued on page 124

SITUATIONS VACANT

W. H. ALLEN SONS & CO., LTD.

invite applications for the following vacancies at their Atlas Works, Pershore, Worcestershire.

SENIOR and JUNIOR DRAUGHTSMEN for expanding Gear Drawing Office. Candidates with general mechanical engineering experience, not necessarily connected with gearing, would be considered.

CONTRACTS ENGINEERS for expanding Gear Sales and Service Section. The work involves estimating and the preparation of tenders, including after-sales service. Candidates should be at least 24 years of age, and have received a recognised engineering training, with subsequent experience in drawing or estimating office.

The above appointments cover interesting work on high-power gearing, individually designed for special industrial and marine applications. Permanent pensionable positions. Canteen facilities. Travelling allowance according to distance from Pershore. —Apply, in confidence, to Personnel Manager (Ref. 829/274), Atlas Works, Pershore, Worcestershire. E8835 A

SITUATIONS VACANT

LLOYD'S REGISTER OF SHIPPING
require a

MECHANICAL ENGINEER

for their testing and experimental laboratory at Crawley, Sussex. Applicants should possess a University Degree in Mechanical Engineering, have at least two years' experience of general mechanical engineering and at least two years' industrial research experience relating to fatigue of machinery components. A knowledge of metallurgy would be an advantage. The post offers good prospects in the Society's service. Age limits 28/40 years.

Commencing salary £1100/£1500 per annum. Apply to: The Secretary, Lloyd's Register of Shipping, 71, Fenchurch Street, London, E.C.3.

E8843 A

SITUATIONS VACANT

A. MONK & COMPANY, LIMITED, WARRINGTON, LANCS.

REQUIRE SITE ENGINEERS for major projects in and around the North Western, North Eastern and South West Midland areas. Permanent and progressive posts. Superannuation Scheme in operation. Applications in confidence stating age, full details of experience and qualifications, etc.—Please reply to Mr. H. Hudson, Personnel Department, A. Monk & Company, Limited, Padgate, Warrington, Lancs.

E8872 A

SITUATIONS VACANT

STEEL, PEECH & TOZER,

branch of the United Steel Cos. Ltd., have vacancies for first class

DESIGN DRAUGHTSMEN

capable of the development and design of steelworks plant and equipment. The positions offered are permanent and present good opportunities to men of ability and initiative. Good working conditions, 38-hour week, and excellent superannuation scheme. Salary according to experience and qualifications.—Applications should be made in writing to the Labour Manager, Steel, Peech & Tozer, The Ickles, Rotherham.

E2718 A

GEORGE WIMPEY & CO., LIMITED

invite applications for the following appointments

in an expanding and progressive department engaged in design and planning of Oil Refinery and Chemical Plants.

DESIGN ENGINEERS, with considerable experience in Oil Refinery and Chemical Plant design and in the preparation of indents, analysis of specifications and quotations for pumps, vessels, compressors and similar equipment. Minimum qualification H.N.C. (Mech.).

DRAUGHTSMEN, with at least three years' experience in PLANT LAYOUT and/or PIPING and/or INSTRUMENTS. Minimum qualification O.N.C. (Mech.).

Permanent appointments; contributory pension scheme after probationary period; good office accommodation; canteen facilities.

Applications, giving age, qualifications and full details of experience, to

SPECIAL PROJECTS OFFICE,
191A, Askew Road, Shepherds Bush, London, W.12.

E8869 A

AIR PRODUCTS (G.B.) LTD.

CHIEF MECHANICAL ENGINEER

This leading Company serving the Government, Chemical, Steel and Gas industries requires a fully Qualified Engineer to manage its machinery activity.

Requirements:

- Understanding of the fundamentals of applied mechanics and thermodynamics.
- Thorough grounding in commercial practice related to the application of centrifugal and reciprocating machinery.
- Ability to negotiate at Management level with Machinery Suppliers in Great Britain and on the Continent.

The successful candidate will spend a period of time with our Parent Company in the United States, in order to gain an appreciation of the technical and commercial aspects of our business.

WRITE TO: PERSONNEL MANAGER,
AIR PRODUCTS (G.B.) LTD.
49-50, Poland Street, London, W.1.

E8818 A

Hawker Siddeley — INDUSTRIAL DIVISION

BRUSH ELECTRICAL ENGINEERING COMPANY, LIMITED

ENGINEERS
ELECTRICAL DRAUGHTSMEN
TENDERING & CONTRACTS ENGINEERS

are required in our General Engineering Division to handle a wide range of comprehensive projects including Transformers, Switchgear, Rotating Machines, Steam, Gas Expansion and Gas Combustion Turbines, Diesel Engines and associated equipment.

If you have a good technical background (Corporate Membership of a Senior Institution, H.N.C. or O.N.C.), some experience of electric power generation, distribution or utilisation of electrical energy and are looking for employment where initiative is welcomed, then you will be interested in joining our expanding General Engineering Division.

Applications, WHICH WILL BE TREATED IN THE STRICTEST CONFIDENCE, should be addressed to the Chief Personnel Officer,

BRUSH ELECTRICAL ENGINEERING CO., LTD.,
Loughborough, Leics., and should quote reference PL 9036.

E8831 A

INSTRUMENT ENGINEERS

Candidates must have some experience in Instrument Engineering and either University Degree or H.N.C. Experience should preferably be in refinery process instrumentations. Operating experience would be an advantage. Duties of the successful applicants will cover the selection of instruments, the determination of their location, and applications in the process; preparation of process control diagrams, instrument specifications and data sheets; writing of requisitions and review of vendors' quotations; instrument calculations, locating the physical position of instruments and the preparation of instrument board layouts.

Above average salaries, comprehensive personnel benefits include contributory pension scheme, excellent working conditions, luncheon vouchers, Social Club, etc.

Please write to the Personnel Manager

KELLOGG INTERNATIONAL CORPORATION
7-10, CHANDOS STREET, CAVENDISH SQUARE, LONDON, W.1. *TEL: MUSEUM 4010.*
quoting reference 155/G

E8857 A

ENGINEERS

required by

THE ATOMIC WEAPONS RESEARCH ESTABLISHMENT, ORFORDNESS, SUFFOLK

To be responsible for a section carrying out mechanical environmental testing. Duties will cover the organisation of tests in conjunction with the parent division at Aldermaston and liaison with other interested sections. The section will also be responsible for assembly and instrumentation and the carrying out of tests in accordance with safety requirements of the Establishment.

Applicants should be Corporate Members of a Senior Engineering Institution, but Graduate Members will be considered. Previous research or development experience is essential, preferably in the field of vibration studies. Candidates will be expected to show they have had experience in co-ordinating and directing the work of others and working in collaboration with other technical groups and outside firms.

SALARY: Within the range £860–£1825, according to age, qualifications and experience.

Contributory Superannuation Scheme. A house may become available for married officers living beyond daily travelling distance, alternatively substantial assistance with house purchase can be given.

POSTCARDS for application forms to the Senior Recruitment Officer at A.W.R.E., Aldermaston, Berks. Please quote ref. 2545/25.

E8807 A

Reed PAPER GROUP

THE REED PAPER GROUP

has a vacancy for a

DESIGNER DRAUGHTSMAN

in the Machine Design Section of the expanding Packaging Division Development Department; minimum qualification H.N.C.

The work will be of an interesting nature and will cover the whole range of present and future packaging developments. Applicants should have had a minimum of 5 years' experience in the design and development of packaging machinery or associated equipment.

Excellent conditions of service include non-contributory pension scheme and assisted house purchase.

Applications in writing to:

The Group Personnel Officer, Albert E. Reed & Co., Ltd.,
Larkfield, Nr. Maidstone, Kent.
quoting reference DD/PDDD/65.

E8883 A

SITUATIONS VACANT

BREWERY ENGINEERS

Large London Brewery has vacancies for Senior Maintenance Engineers in Brewing and Bottling Departments. Steam Raising, Refrigeration and Electrical knowledge essential.

Write full details, qualifications, etc., to BOX No. E2717, "The Engineer."

A

PROJECT ENGINEER

required by nationally-known engineering company in the Manchester area, specialising in Rubber, Plastic and Hydraulic Machinery.

Applicants should have initiative and a high sense of responsibility, a University Degree or equivalent. He will be required to meet customers and discuss their problems with a view to getting out the necessary designs and drawing up of specifications, experience in Rubber or Plastic industry or plant would be an advantage.

This post has a non-contributory pension and life assurance scheme.

The staff have been advised of this vacancy.

All applications will be treated in the strictest confidence.

Write in the first instance to :

Personnel Manager,
FRANCIS SHAW & CO. LIMITED,
Corbett Street, Ashton New Road,
Manchester, 11.

E8827 A

A SENIOR PRODUCTION ENGINEER

is required by a progressive Company engaged in the Mass Production of

LIGHT ENGINEERING COMPONENTS

in the South Midlands.

The business is highly competitive and the essential features of our forward programme are increasing productivity coupled with the highest standards of precision ; it is towards achieving and maintaining these ends that the person appointed will be required to work, through the study of individual technical and practical production problems.

The salary, conditions and prospects offered will be in keeping with the high degree of importance attached to this new appointment.

Applications are invited from qualified Mechanical Engineers who have had a minimum of 10 years' experience in responsible technical positions of a similar nature. They should give full details of background, experience and present position, in the fullest confidence, to BOX No. E8850, "The Engineer."

A

We wish to appoint a

TECHNICAL ASSISTANT

to supervise testing in a small laboratory concerned with technical service and applied research on lightweight structures.

Applicants should preferably :—

(*a*) be aged between 22 and 27,
(*b*) have an H.N.C. or equivalent qualification in mechanical engineering or applied physics,
(*c*) have at least two years' testing experience.

They must also be able to use their own ideas and initiative.

This appointment provides an opportunity both to join an expanding company and to gain further experience and responsibility.

Those interested will find conditions excellent and the salary payable will be discussed at an interview. Letters of application, setting out all relevant information and stating present salary, should be sent to :

CIBA (A.R.L.) LIMITED,
DUXFORD,
Cambridge. E8848 A

CHIEF DRAUGHTSMAN

Must be time-served engineer and capable of leading a medium-size drawing office engaged upon the design of medium to light high-grade machines of mechanical, hydraulic and partly electrical types.

Important qualifications are enthusiasm, an inventive mind, a modern approach, a willingness to co-operate, and the previous holding of a similar post.

There are excellent prospects for the right type of man.

Write, giving age, present earnings and fullest particulars of experience and posts held, to Mr. H. M. Denison, Saml. Denison & Son, Ltd., Hunslet Foundry, Leeds, 10.

E8859 A

SITUATIONS WANTED

ENGINEER, age 38, seeks change. Engineering apprenticeship. H.N.C. standard. Experienced : Heavy Engineering, Plant Installation and Maintenance, Supervisory capacity, Light Mass Production Engineering, Plant Purchasing, Methods, Planning and D.O. Mobile in Southern Counties. Willing to travel. Overseas appointment considered.—BOX No. E2712, "The Engineer." B

BUSINESS OPPORTUNITIES

REMPLOY SPONSORSHIP SCHEME.—Send for details which show an attractive proposition to manufacturers.—Write to the Managing Director, Remploy, Ltd., 25–28, Buckingham Gate, S.W.1, or telephone VICtoria 6621 (12 lines). E155 O

AN OPPORTUNITY FOR A SMALL ENGINEERING WORKS WISHING TO SECURE ITS FUTURE

Well-known and long-established engineering company in South Midlands is anxious to acquire controlling interest in well-equipped general engineering works employing 200-300 men, mostly skilled, and having a balanced machine shop and fitting shop capacity suitable for building steam turbines. Maximum sizes of machine tools required are based on No. 3 horizontal boring mills, 36in. centre lathes and 48in vertical mills. —Reply BOX No. E8852, "The Engineer."

O

BUSINESSES and PREMISES

COLCHESTER, ESSEX.—New SINGLE-STOREY FACTORY to be erected on 3-acre corner site with valuable frontage to main Harwich Road. Will provide about 60,000 sq. ft. Companies and Organisations interested to rent or purchase, apply Developers, 18, Upper Brook Street, London, W.1. E8847 L

FOR HIRE

LATTICE STEEL ERECTION MASTS (light and heavy), 30ft. to 150ft. high, for immediate hire.—Bellman's, 21, Hobart House, Grosvenor Place, S.W.1. E103 K

MOBILE LIFTING SERVICES.—Lump sum or Hire Rate Quoted for any Lifting Work by Lorry-Mounted or Crawler Cranes, any size, any area.—TARSLAG, LTD., Rotherham 3235. E168 K

600

FORK LIFT TRUCKS FOR HIRE

Modern Machines Only
Diesel & Battery/Electric
Capacities 2000 lb–18,000 lb.
Contact your nearest Depot :

GEORGE COHEN,

SONS & CO. LTD.
WOOD LANE, LONDON, W.12.
(Shepherds Bush 2070)
And at Stanningley (Nr. Leeds) . Kingsbury (Nr. Tamworth) . Manchester . Glasgow Swansea . Newcastle . Belfast . Sheffield Southampton . Bath

E200 K

MISCELLANEOUS

DAVIES INVESTMENTS LTD., BANKERS

Continue to offer 7½ per cent. on sums £20–£500 (withdrawal on demand) with extra ½ per cent. on each £500 unit.

Details and Audited Balance Sheet from Investment Dept. ER,
DAVIES INVESTMENTS LTD.,
DANES INN HOUSE, 265, STRAND,
LONDON, W.C.2.

E178 I

100 PER CENT. DEFERRED, 95 PER CENT. IMMEDIATE MORTGAGE. 2nd Mortgages our speciality. Apply without obligation.—Cranbrook Mortgage Bureau, 49, Cranbrook Road, Ilford, Essex. E177 I

SUB-CONTRACTING

KELLERING AND CAM PROFILING capacity up to 8ft. by 6ft. or 6ft. diameter.—ARMYTAGE BROS. (KNOTTINGLEY), Ltd., The Foundry, Knottingley, Yorkshire (Telephone : Knottingley 2743/4). E116 MW

WELL-KNOWN COMPANY'S SOUTHERN SERVICE WORKS ideally situated in N.W. precincts of London whilst mainly engaged in heavy engineering and mechanical handling equipment, has capacity available for assembly and supply of component parts, &c.—Write BOX No. E2688, "The Engineer." MW

PATENTS

THE PROPRIETORS of British Patent No. 748,454 for "IMPROVEMENTS IN JOINTS FOR CONNECTING RIGID PIPE SECTIONS," desire to enter into negotiations with a firm or firms for the sale of the patent or for the grant of licences thereunder.—Further particulars may be obtained from Marks & Clerk, 57 & 58, Lincoln's Inn Fields, London, W.C.2. E8815 H

MACHINERY Etc. WANTED

WANTED.—One 500/1000 h.p. Ward Leonard Set, input voltage preferably 3000/3300 volt, 3-phase, 50 cycles.—Full details, price, &c., to BOX No. E8803, "The Engineer." F

WANTED.—SECOND-HAND OVERHEAD TRAVELLING CRANE, 40/50-ton capacity, 40ft.–60ft. span, to suit 400 volt, 3-phase, 50 cycle supply. Advertiser is actual user.—BOX No. E2713, "The Engineer." F

FOR SALE

SERVICE EDWARDS VALUE!

BRADLEY & CRAVEN Size No. 6, Open-Fronted Geared Inclinable Power Press, motorised for 400/3/50 cycles supply, pressure exerted 60 tons, stroke 4in., bed 29½in. by 19in., weight approximately 75 cwt.

CRAIG & DONALD Model 400/10, All-Steel Double Geared Press Brake, motorised for 440/3/50 cycles supply, pressure exerted 400 tons, forming capacity 10ft. by ¾in., weight approximately 29 tons.

WESTON MODEL 400/100, Double-Sided Friction Screw Press, of welded steel plate construction, arranged motor drive for 400/3/50, pressure exerted approximately 120 tons, maximum stroke 11in., diameter of screw with four starts 6¼in., size of bed 21¼in. by 18in., weight approximately 5 ton 8 cwt.

TAYLOR & CHALLEN Power-Operated Circle Cutting Machine, motorised for 400/440/3/50, capacity 16 S.W.G. mild steel, cuts circles from 7in. to 52in. diameter, weight approximately 8 cwt.

RUSHWORTH Power Operated Double-Geared Open-Ended Guillotine Shearing Machine, over-crank type, arranged motor drive for 380/440/3/50, capacity mild steel 4ft. by ¼in., gap in open ends 6¼in., weight approximately 50 cwt.

NEW MUBEA All Steel Construction Bar and Angle Shear, arranged motor drive for 400/3/50, capacity round bars 2in., square bars 2in., flat iron 10in. by ¾in., 5¼in. by 1in., angles up to 4in. by ¾in., 5in. by ·425in., tee iron 5in., beams 6in., channels 6in., length of blades 12¼in.

TWO NEW BESCO Type F, 80¼in. by 14 gauge Hand-Operated Universal Swing Beam Folding Machines, with high lift clamping beam and adjustable bed, smallest trunk section formed 11in. by 9¼in., maximum working length 80¼in., capacity mild steel 18 S.W.G., height of lift of clamping beam 6in.

Photographs of the above are available.

Very favourable Hire Purchase terms can be obtained.

MACHINE TOOLS, NEW AND USED,
Of Every Description. Attractive Prices.

F. J. EDWARDS LTD.,

359–361, EUSTON ROAD,
LONDON, N.W.1
Telephone : EUSton 4681–3771.
And at
LANSDOWNE HOUSE, 41, WATER STREET, BIRMINGHAM, 3.
Telephone : Central 7606–8. E207 O

FOR SALE

SOAG

HIGH DUTY LATE TYPE
PLANERS — SHAPERS — SLOTTERS
IN STOCK
ATTRACTIVE PRICES

PLANERS

16ft. by 4ft. by 4ft. STIRK "HILOPLANE," Double Column, 2 tool heads on cross rail and 2 side heads, all electric variable speed D.C. drive, cutting speeds 20ft. to 140ft.

13ft. by 3ft. 3in. by 3ft. 3in. BERTHIEZ Double Column. Planes both ways. 2 tool heads on cross rail and 2 side heads. Built 1951. All electric 415V., 3 ph., 50 cy. Cutting speeds variable from 13ft. to 330ft. per min.

12ft. by 4ft. 3in. by 3ft. CINCINNATI/HYPRO Double Column, 2 T.H. on cross rail and one side head ; drive as above.

TRAVERSING HEAD SHAPERS

32in. BUTLER Double Head Type, with four tables, two-motor drive, max. length of stroke 32in., max. distance between centres of heads 7ft.. 3in., max. bed length 12ft. H.p. of motors each 20.

32in. ORMEROD Single Head Type, with two tables, motor drive, length of bed 8ft., No. of speeds to ram 9, max. distance table to ram 18in., h.p. motor 20.

SLOTTERS

21in. BUTLER High Production, table dia. 45in., max. dia. admitted 70in., motor drive and pendant control.

16in. BETTS-BRIDGFORD Heavy Duty, table dia. 34in., admits in dia. 70in., h.p. motor 7½.

14in. BUTLER High Production, table dia. 39in., admits in dia. 60in., h.p. motor 12½.

12in. THULE High Speed, Type ST12, 1952, with swivel head (12 deg.), multi-motor drive, table dia. 24in., admits in dia. 45in., h.p. motor 5.

8in. ORMEROD High Speed, table dia. 18in., admits in dia. 30in., h.p. motor 4.

All machines motorised 400 volts, 3 phase, 50 cycles

INSPECTION INVITED

Full details from :—

SOAG MACHINE TOOLS, LTD.,
JUXON STREET, LAMBETH, LONDON, S.E.11.
'Phone : RELiance 7201.
'Grams : "Sotoolsag," London, S.E.11.

E8854 O

600

PROCESS PLANT FOR SALE

ROTARY DOUBLE SHELL DRIER by Edgar Allen, 16ft. long by 3ft. 4in. dia., rotating on two roller paths and driven through reduction gears by 5 h.p. motor, final speed 6·75 r.p.m., oil-fired with separate firebox 5ft. 8in. by 4ft. 1in. by 4ft. 6in. high, brick-lined, Urquhart atomiser, Cyclone fan driven by 4 h.p. motor mounted on stand.

ROTARY DRIER by Manlove Alliott, 23ft. 6in. long by 6ft. dia., shell of ⅜in. mild steel welded construction with serrated flights and spiral plates, drive through girth gear and pinion and counter-shaft by 20 h.p. 400/3/50 cycles motor, 24in. dia. paddle-type Fan driven by 7 h.p., 400/3/50 cycles motor, 6ft. dia. cyclone and screen discharge hood.

No. 15 ROTARY DRUM DRIER by Buell, 26ft. long by 5ft. dia. flange bolted in two halves of ⅜in. riveted steel construction, drier on two roller paths, arranged for solid fuel firing, with High Efficiency Cyclone, Fans, and ducting.

HORIZONTAL CYLINDRICAL STEAM JACKETED VACUUM DRIER, approx. 15ft. 9in. long by 3ft. dia., ¼in. steel plate construction, glanded steam tube and paddle agitator gear driven through pinion by F. & L. pulleys, Drier mounted on cradles and provided with two 12in. by 8in. outlets fitted swing doors.

ATRITOR/PULVERISER by Alfred Herbert, size No. 12, driven by 50 h.p. 380/420/3/50 cycles motor, mounted on combined bedplate with starter, rotary feed table driven by ¾ h.p. 380/420/3/50 cycles motor, electromagnets belt magnetic separator driven by ½ h.p. motor through gearbox, welded mild steel Cyclone, 5ft. dia. by 5ft. deep on straight conical portion with rotary air lock.

SUPER SPARTAN RECIPROCATING SCREEN by Robert Cort, 4ft. wide, comprising two parallel trays each 16ft. 6in. long, suspended from framework by rocking links, first tray with ¾in. dia. perforations, 3 panels with 1¼in. dia. perforations and one dead plate ; second tray 1¼in. dia. perforations and four dead plates, each tray connected to overhead driveshaft fitted two fly-wheels, mounted on roller bearings and vee belt driven from 5 h.p. 400/440/3/50 cycles motor with starter.

GEORGE COHEN,

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Classified Advts. continued on page 126

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NEALS "NM" 2-ton MOBILES, 35ft. Lattice, Ruston engine, pneumatics, 1951-52. £1100/£1250 each.
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BUTTERS 5-ton 2-motor ELECTRIC DERRICK, 120ft. Jib. No. 5555. £2250.
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ANDERSON 7-ton 2-motor ELECTRIC DERRICK 120ft. Jib, approx. 1952. Offers.
MORGAN 10-ton 2-motor ELECTRIC DERRICK, 120ft. Jib, 1954, bogies available. £4950.
RUSHWORTH 2-motor 10-ton ELECTRIC DERRICK CRANE, 70ft. Jib, New 1957, very good condition. £3850.
MORGAN 15-ton STEAM DERRICK, 120ft. Jib, new 1958, on bogies. £8750.
BUTTERS 15-ton 2-motor ELECTRIC DERRICK, 120ft. Jib, 1955. Price on application.
COLES R.2310 20-ton DIESEL/ELECTRIC RAIL CRANE, 30ft. Jib, with Cab, S.L.I. Air pressure brakes, 4ft. 8½in. gauge, with magnet, Perkins engine, new August, 1956, excellent condition. £8750.
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E8877 G

"SAMUEL PLATT" 800 LB. MOTORISED FRICTION BOARD DROP HAMMER for sale. Length of drop 5ft. Between uprights 14in. Size of anvil 17in. by 31½in. Electrical equipment for 400/440/3/50. Weight about 10 tons.—F. J. EDWARDS LIMITED, 359, Euston Road, London, N.W.1, or 41, Water Street, Birmingham, 3. E8876 G

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230kVA., 600 r.p.m., comprising 280 h.p., 7-cylinder, type EPV.7, engine driving alternator by BRITISH THOMSON HOUSTON.

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169kVA., 600 r.p.m., comprising 270 h.p., 6-cylinder, type EPV.6 engine, driving alternator by BRUSH ELECTRICAL.

168·75kVA., 600 r.p.m., comprising 200 h.p., 5-cylinder, type EPV.5 engine, driving alternator by CROMPTON PARKINSON.

165kVA., 500 r.p.m., comprising 200 h.p., 6-cylinder, type EPV.6 engine, driving alternator by ELECTRIC CONSTRUCTION CO.

147kVA., 500 r.p.m., comprising 168 h.p., 5-cylinder, type EPV.5 engine, driving alternator by CROMPTON PARKINSON.

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(2) ONE PAIR Duplex "Weir" RECIPROCATING (STEAM) FEED PUMPS for above. New 1957.
(3) ONE Radiovisor Industrial SMOKE DENSITY INDICATOR.
(4) ONE CO_2 RECORDER, range 0/20 per cent.
Items 3 and 4 in one cabinet.
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2000kW Metropolitan-Vickers TURBO-ALTERNATOR SET, pass out Turbine 250 lbs. pressure, pass-out 30 lbs., coupled through reduction gearbox to Alternator, 440 volts, 3-phase, 50 cycles, 1000 r.p.m., condensing plant and control gear.
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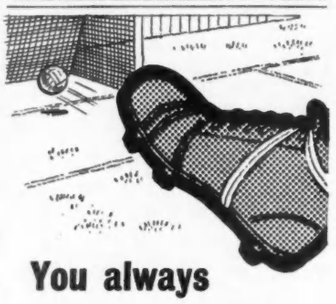

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DERRICK CRANES.—7-ton Anderson Grice, 100ft. jib, electric; 7-ton Rushworth, hand, 30ft. jib; 5-ton Wilson, electric, 70ft. jib; 1½-ton Anderson Grice, hand, 40ft. jib.
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LOCOS.—Fowler diesel, 150 h.p. (2); Barclay & Ruston 80/88 h.p. diesel; Bagnall 14in. by 22in. (two oil-fired, one coal), Peckett, steam, 7in. by 12in., 1941; also 3 miles track, 24in. gauge, Bogies, Turnouts, &c.
STEEL PIPING.—50,000ft., 2in. Galvanised, new; 60,000ft., 3in. black, new; 5000ft., 8in. seamless; 1000ft., 12in. seamless; 500ft., 14in. seamless; 400ft., 18in. riveted; 280ft., 21in. o.d. welded flanged; 3800ft., 21in. seamless flanged; 500ft., 24in. riveted; 1450ft., 27in. o.d. welded flanged; 216ft., 48in. riveted; 216ft., 60in. riveted.
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SALES BY AUCTION

		Main Location	*Auctioneers*
February 18	Miscellaneous stores, including :—	M.O.A. Storage Depot, Rotherwas, Hereford.	RUSSELL, BALDWIN & BRIGHT, LTD. (Dept. L), 20, King Street, Hereford. (Tel.: 4366.)
	Tyres and tubes; petrol driven auto trucks; chain blocks; metal binning; tarpaulins; M.T. spares and equipment; electric induction and other motors; electrical equipment; wire; cable; furniture, including stacking chairs; clothing; blankets; mattresses; curtains, etc.		
February 25	Vehicles and miscellaneous stores.	M.O.A. Storage Depot, Bowhouse, Hurlford, Nr. Kilmarnock, Ayrshire.	DIXON & WALLACE, LTD. (Dept. L), Bank Buildings, Graham Street, Glasgow, E.1. (Tel.: Bridgeton 2447/9.)
March 1	Machine tools and miscellaneous stores.	M.O.A. Storage Depot, Byley, Nr. Middlewich, Cheshire. (Sales at Cheetham Town Hall, Manchester 8.)	J. H. NORRIS & SON, (Dept. L), 9, Albert Square, Manchester, 2. (Tel.: Blackfriars 8373.)
March 8–10	Machine tools and miscellaneous stores.	M.O.A. Storage Depot, Royal Arsenal, Woolwich, London, S.E.18.	FULLER, HORSEY, SONS & CASSELL (Dept. L), 10, Lloyd's Avenue, London, E.C.3. (Tel.: Royal 4861.)
March 15	Miscellaneous stores.	Central Ordnance Depot, Didcot, Berks.	SIMMONS & SONS (Dept. L), 12, Station Road, Reading, Berks. (Tel.: 54025.)
March 15–18	Vehicles, earth moving and lifting equipment.	M.O.A. Storage Depot, Ruddington, Notts.	WALKER, WALTON & HANSON (Dept. L), Byard Lane, Bridlesmith Gate, Nottingham. (Tel.: 54272.)
March 22–23	Vehicles and miscellaneous stores.	Central Ordnance Depot, Bicester, Oxon.	MIDLAND MARTS, LTD. (Dept. L), Market Square, Bicester, Oxon. (Tel.: 73.)

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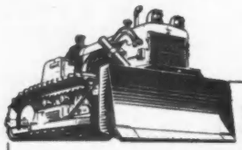

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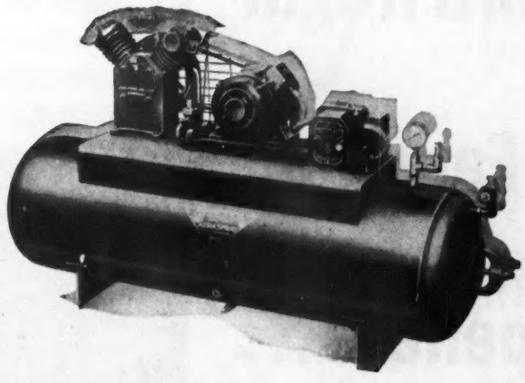

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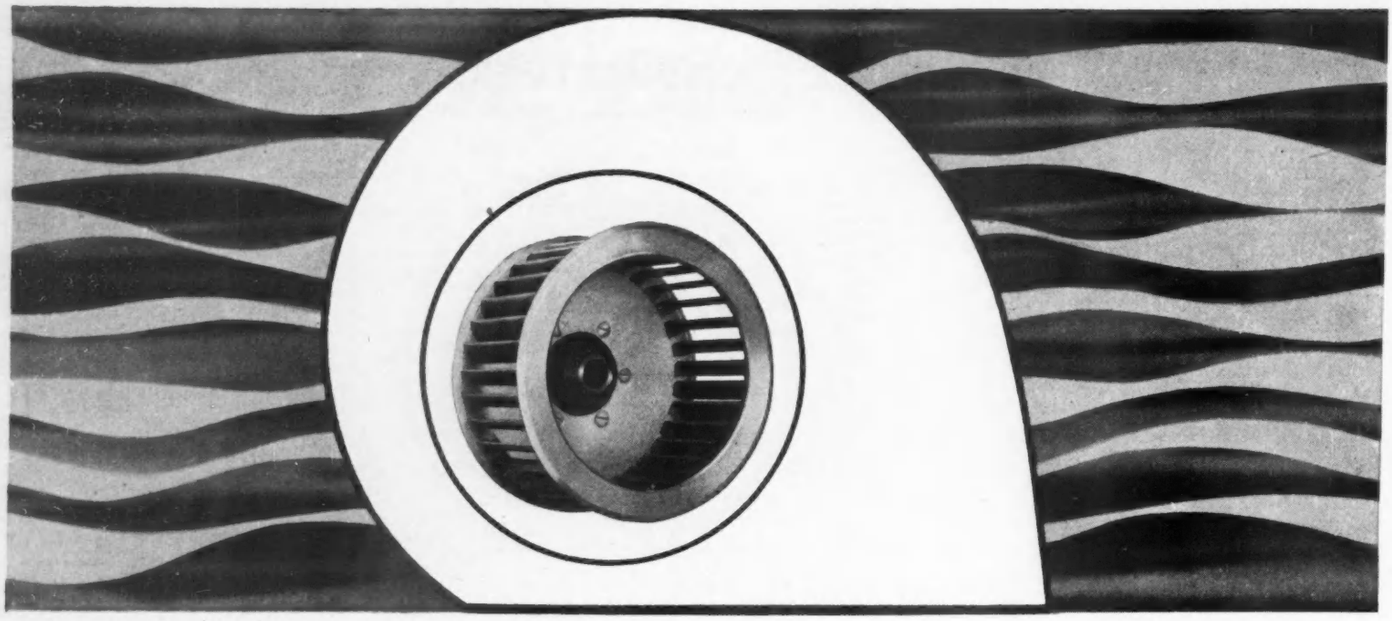

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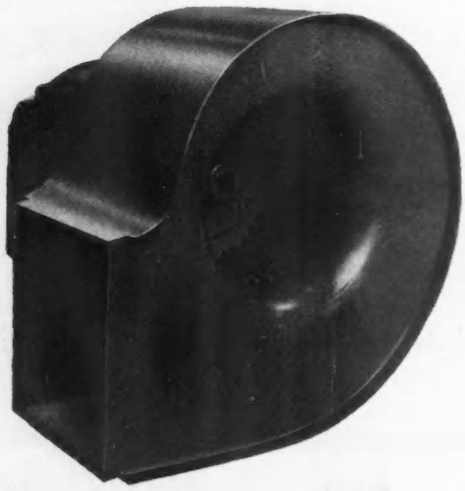

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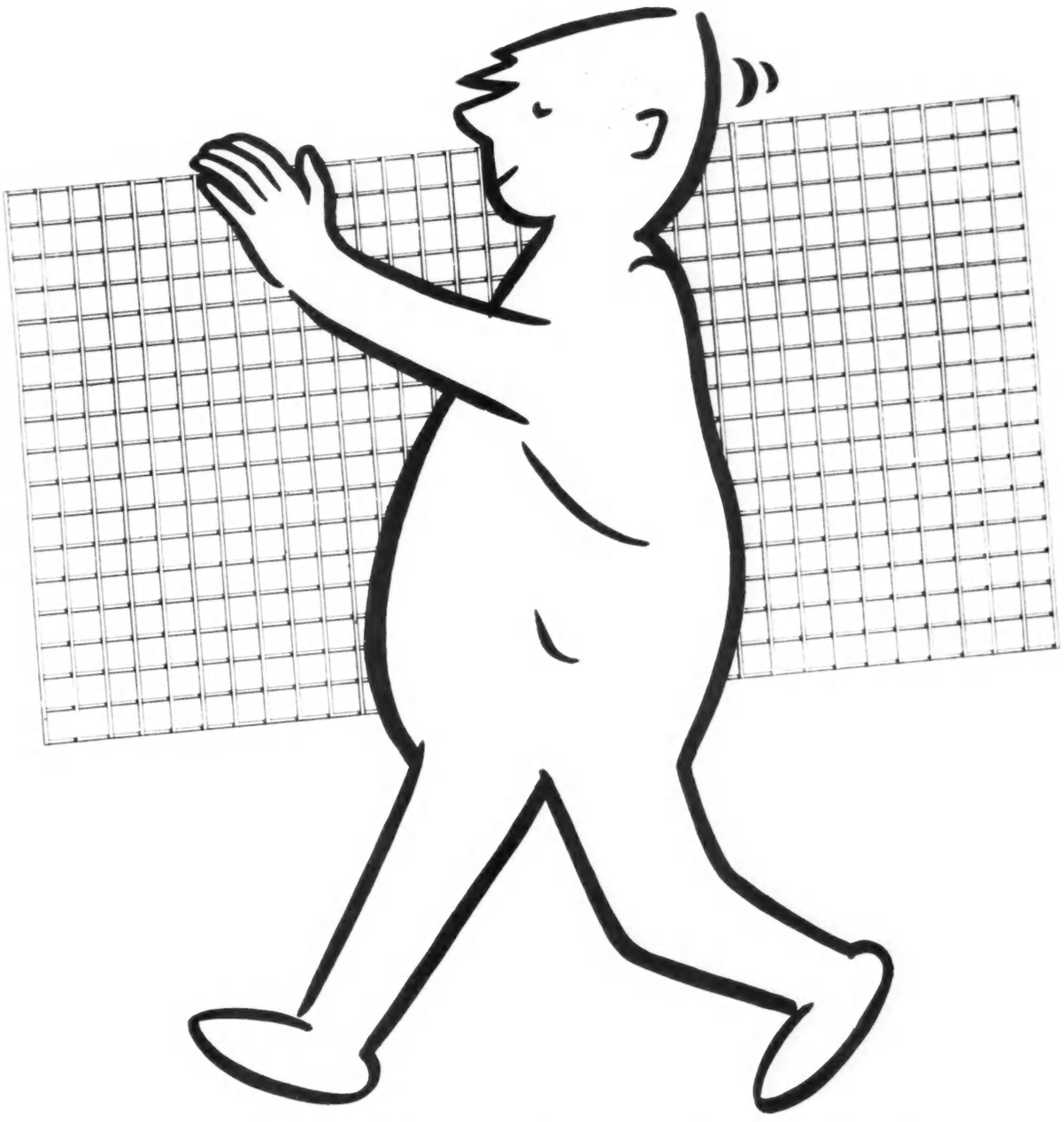

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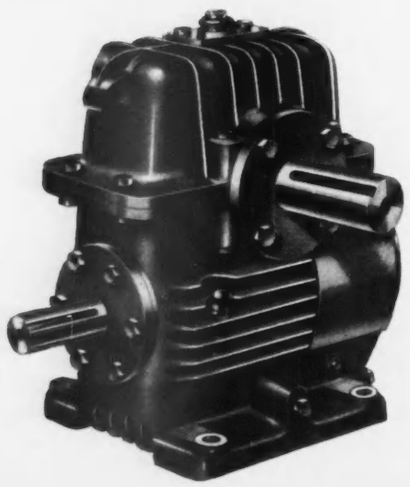

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